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METHODS OF PREPARING AND USING RADIOACTIVE SUBSTANCES IN THE TREATMENT OF MALIGNANT DISEASE, AND OF ESTIMATING SUITABLE DOSAGES.

By William Duane, Ph.D., Boston.

[From the Cancer Commission of Harvard University.]

About four years ago the writer came to Boston, on the invitation of the chairman, and proposed to the Harvard Cancer Commission an investigation of the effects of radium rays on malignant disease, when applied by certain new methods. The Commission decided to take up the work, and we now see at the Huntington Hospital over five hundred new cases of malignant disease a year, almost all of which receive more or less treatment with radioactive substances. In some cases, very satisfactory results have been obtained, giving what may be called apparent cures. In others, marked alleviation has been observed, with prolongation of life and increased comfort; and in other cases still, no benefit, and possibly added discomfort, may have been produced. The fact that the medical profession keeps sending us so many cases for treatment would seem to indicate that we are doing a useful work in the community, and this, together with the character of the results actually obtained warrants the publication of a detailed statement of the methods employed in preparing the radioactive substances, of the methods of measuring the dosage, and of the general principles upon which the character of the treatment is determined.

The following paper contains a description of the scientific principles employed in the preparation of the applicators and of the instruments for measuring their radioactivity, and a brief statement of the kinds of cases in which the various methods are used and the dosages actually employed.

In order to make clear the principles underlying these investigations, it will not be out of place to state a few of the well-known facts and laws that have been discovered in the branch of science called "Radioactivity."

Radium is a chemical element belonging to the group of metals, but unlike most other elements, it is not extraordinarily stable. It transforms itself at a measurable rate into another substance called radium emanation. The rate of transformation, however, is so slow that about 1700 years would be required for half a given quantity of radium to disappear.

The emanation is a chemically inert gas, and it, too, transforms itself into a third substance called Radium A; but this is not all. Radium A transforms itself into Radium B, and Radium B into Radium C, etc., thus forming a series of substances related to each other as father to son. The last of the line known to exist is Radium F, also called polonium; which, as a matter of fact, was the first radioactive substance discovered by the Curies. Considerable evidence also has been collected of late years in favor of the supposition that polonium transforms itself into lead.

None of the above substances are gases except the emanation. Radium A, B, and C deposit themselves on anything and everything that comes in contact with the emanation, including the walls of the vessel that contain it. For this reason, Radium A, B, C, etc., frequently are grouped together under one name, and called collectively "deposited activity." These substances transform themselves much more rapidly than their grandparent, radium itself, does. Half a given quantity of emanation disappears in three and eighty-five-hundredths days: half a given quantity of Radium A, in three minutes; of Radium B, in twenty-six and eight-tenths minutes; of Radium C, nineteen and five-tenths minutes, etc. Thus the emanation lasts longer than the deposited activity; the former's life being measured in days, and the latter's in minutes. These substances differ from each other very much in their physical and chemical properties, but they have one characteristic in common,—they are radioactive.

By radioactive substance, we mean a substance that continuously emits peculiar types of invisible rays that differ substantially from light and heat rays. The radiation from radioactive substances, if sufficiently intense, destroys tissues, and this fact forms the basis of the therapeutic applications of the radioactive substances. In such applications, one or more of the radioactive substances, in a special container, is placed in or near the malignant growth to be treated, or is injected into the growth in the form of a solution, and the rays from the substance, passing through the tumor cells, destroy them.

Among the above-mentioned substances, Radium C produces by far the most penetrating rays. Radium B also emits some penetrating rays; but neither radium nor the emanation produces rays that are capable of passing through the walls of the glass tubes in which they are usually kept. "Why, then," it may be asked, "are tubes containing radium used for therapeutic treatment?" The answer is that they are not so used until the radium has been in them long enough for the Radium B and C to accumulate. When this has occurred, the only function fulfilled by the radium is to supply Radium B and C as fast as they destroy themselves, the latter being the real source of the penetrating radiation.

It follows, therefore, that, if by suitable means we deposit Radium B and C on an applicator or in a tube, we can use the applicator or tube to radiate tissues, just as if it contained radium itself, and this is the fundamental principle of the methods about to be described.

The deposit of Radium B and C can be obtained in a variety of ways, of which the following may be mentioned:

(1) The emanation may be extracted from the radium and pressed into a glass or metal container of any desired shape and size, and the Radium ABC allowed to accumulate in it. The container is then ready for use, either with or without the emanation, according to the length of time required for the treatment. The emanation, if left in the container, simply prolongs the time during which the activity lasts, by keeping up a supply of the Radium BC. The emanation itself does not add to the penetrating radiation.

(2) Radium ABC may be deposited on sheets of metal or other substances by leaving them for several hours in contact with the emanation contained in the closed chamber. The sheets are then attached to the tissues, to be radiated by adhesive plaster or otherwise.

(3) Radium ABC may be dissolved in water or other liquid, either by dissolving the purified emanation and allowing it to transform itself into Radium ABC, or by depositing the Radium ABC on grains of salt (or other substances) and then dissolving the salt in the liquid. In this way, a large amount of activity can be put into a few drops of liquid. The liquid is then injected in the tissues or blood-stream.

In order that these methods shall be of practical value, it is necessary to have an efficient machine for collecting and purifying the emanation. Such a machine was designed several years ago by the writer.

The general principles of the method are those previously employed by Ramsay and Soddy, Rutherford, and Debierne, in some of their most important researches. The advantages of the method described below are: that the purification does not require liquid air; that a large number of millicuries of emanation can be purified and compressed into a small fraction of a cubic millimeter, in ten or fifteen minutes of time; that no emanation is lost except that due to its natural decay; and that the process may be repeated a great many times without renewing parts of the apparatus.

Fig. 1 represents the arrangement of the glass tubes and reservoirs. The bulb A contains the radium salt dissolved in water. Radium in solution continually decomposes the water into hydrogen and oxygen, and at the same time transforms itself into the emanation, which is set free. The total volume of the hydrogen and oxygen amounts to more than two hundred thousand times that of the emanation at the same pressure and temperature. In addition to the oxygen and hydrogen and emanation, a small quantity of helium appears (the volume of which is a few per cent. greater than that of the emanation) and also traces of other gases, probably carbon dioxide and hydrocarbons coming from the decomposition of organic impurities, although the source of these traces of gas does not seem to be thoroughly understood. On account of its radioactive transformation, the exact proportion between the quantity of emanation and the gases with which it is mixed, depends upon the length of time the gases are allowed to accumulate. In the ordinary daily routine of our laboratory, however, the problem resolves itself into the extraction of 140 to 240 millicuries of emanation having a volume of 0.084-0.144 mm.[3] at atmospheric pressure and ordinary temperature, from a mixture of gases, having a volume of 18 to 36 cc. at the same temperature and pressure.

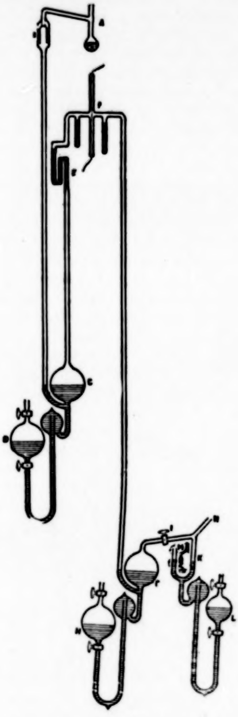


FIG. 1.

The mixture of gases collects in A and the tube B, and also, if the passage is open, in the reservoir C. Allowing the gases to collect in C apparently increases the efficiency, probably because the emanation diffuses from the solution into a large volume more freely than into a small one. The tube B is considerably longer than 76 cm. so that air may be admitted into C, if desired, without its finding its way up into the radium solution. The trap at B protects against mercury spurting up into the radium solution, should some of the glass apparatus break. An ordinary water aspirator with suitable stopcocks controls the flow of mercury between the reservoirs C and D. On admitting the air into D, the mercury rises in C, pushing the mixture of gases through the mercury trap E, into the tubes F. The mercury in the trap E holds back all but a very small quantity of the water vapor. The tubes F contain a copper wire, slightly oxidized, phosphorpentoxide and potassium hydroxide. Although represented in the figure in a vertical position, the copper wire really lies horizontal. It is wound on a quartz rod supported by quartz feet, so that the wire does not touch the inner surface of the tube at any point. The diameter of the wire is 0.3 mm. and the length of the coil 25 cm. When heated red hot by an electric current of 5-10 amperes, it rapidly combines the oxygen and hydrogen, the phosphorpentoxide absorbing the water vapor formed. A small amount of copper oxide on the wire is required, because the mixture of gases contains (at least at first) a quantity of hydrogen that exceeds by a few per cent. the proportion required by the chemical formula for water. Some oxygen remains in the radium solution as hydrogen peroxide. The copper wire was heated for a long time to remove as much of the occluded gases as possible, and the phosphorpentoxide was distilled into its present position from a tube sealed on just below it, and afterwards removed, both of these processes taking place in vacuum. The potassium hydroxide is for the purpose of absorbing any carbon dioxide that may be present, or may be formed by the hot copper wire oxidizing hydrocarbon gases.

After the purification of the emanation the mercury in the reservoir G is drawn into H, the air being removed from H by the water aspirator, and the emanation and helium pass into G. The gases are then pushed up by the mercury through the stopcock I and into the desired tube or container, which is sealed on at N. The volume of the helium being very small, for the vast majority of purposes it is unnecessary to remove it. The length of the tube connecting E with G should be so great that air may be admitted into G without forcing the mercury up into F.

The stopcock I has a mercury seal, and contains no stopcock grease. A few marks made with a lead pencil on the stopper allow it to turn freely. It will be noticed that the emanation passes through no stopcock except the one at I, and even this is unnecessary, and has been added for convenience of manipulation only. The fact that stopcock grease and many other organic substances are decomposed by the rays from the emanation and give off gases is well known.

The system of tubes and bulbs K, L, M is for the purpose of removing the air from the other tubes and reservoirs, etc., by means of a pump attached at M. This must be done at the beginning, and after that no air enters the reservoirs except occasionally when it becomes necessary to renew the oxidized wire or the phosphorpentoxide, etc.

The apparatus in our laboratory has been in continuous use for more than four years. The bulb A now contains over nine hundred twenty milligrams of radium (element), and the total quantity of emanation purified per month amounts to more than 4.5 curies of emanation. A curie is the quantity of emanation in equilibrium with one gram of radium (element).

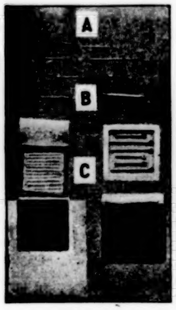


Fig. 2.

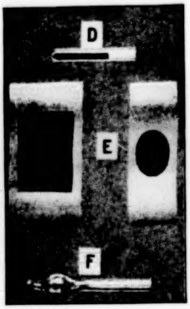


Fig. 3.

One of the most important advantages in using the emanation instead of the radium salt itself for treating cancer, is that the emanation can be put into tubes that are very much smaller than the tubes would have to be to contain an equivalent amount of radium, and also because a much greater variety in the size and shape of the applicators can be obtained.

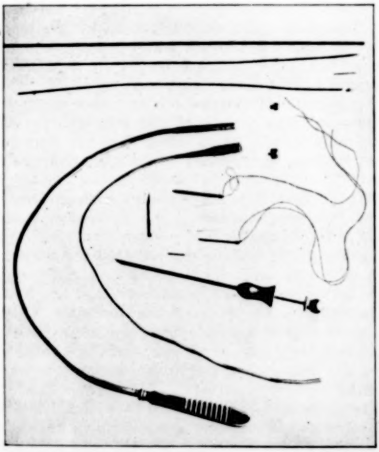


Fig. 4.

Figs. 2, 3, 4, and 5 represent some of the tubes and applicators in use in the Huntington Hospital. The small glass tubes at A in Fig. 2 contain radium emanation. They were originally joined at N to the emanation apparatus represented in Fig. 1, and were sealed from it by means of a very small gas flame, after the emanation had been pushed into them by a column of mercury.

Usually these glass tubes are placed in steel tubes shown just below them in Fig. 2. The steel tubes have an eye that screws into one end, and a more or less sharp point that screws into the other end. The eyes are for threads, which are usually colored, and a record is kept of the amount of emanation in the tube. It often happens that for treating a particular case, it is desirable to cut off the easily absorbed rays, and this is done by surrounding the steel tubes by larger tubes (represented in Fig. 2), a millimeter or two thick, of silver or lead or platinum, according to the amount of filtration desired.

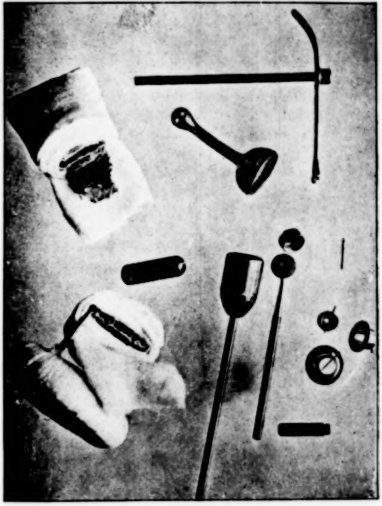


Fig. 5.

Sometimes it is desired to cover a large area of the skin with a lot of tubes of small strength. The metal frames in boxes represented at C in Fig. 2, are convenient for this purpose, and may contain either the glass tubes or the glass tubes inside the steel tubes; they are fastened by means of adhesive plaster as represented.

E (Fig. 3) represents the applicators on which the deposited activity has been placed. There is no emanation in them. In order to make these applicators, a sheet of metal is wrapped on the inside of a glass tube, as at D, and this glass tube is sealed on to the apparatus of Fig. 1, at N. The emanation is then pushed up over the mercury until it occupies the space inside of the metal sheet at D, and is left there for several hours for the deposited activity, Radium ABC, to accumulate. At the end of about three hours, the maximum amount has accumulated. The emanation is then withdrawn through the stopcock I in Fig. 1, into the globe G in order to save it, and after closing the stopcock the tube is cut off and the metal sheet spread out on adhesive plaster as at E in Fig. 3. The applicator is then applied over the area as desired. This method of treating cases is useful in very superficial lesions covering large areas, in which it is desired to get a uniform radiation over the whole surface. It has the advantage that a uniform, and, if desired, very small filtration can be obtained.

F in Fig. 2 represents a bulb used in preparing intensely radioactive solutions. A few grains of ordinary salt are placed in the small bulb at the extreme left end of the tube; the tube is then sealed to the emanation apparatus at N and the purified emanation, pushed up in between the grains of salt, and left there for three hours. The deposited activity, Radium ABC, accumulates on the grains of salt. At the end of three hours or so, the emanation is removed and put into the globe G; the glass bulb is cut off from the emanation machine, and distilled water squirted into the small bulb containing the activated salt. The salt dissolves in the water, carrying with it into solution most of the deposited activity, Radium ABC. If care is taken to use the proper amounts of salt and distilled water, a physiological salt solution can thus be obtained, containing a very large quantity of deposited activity per cubic centimeter.

Solutions of this kind have been used in the Huntington Hospital for injections into the blood-stream and into tumor tissues.

Fig. 4 represents tubes that have been used in cases in which it was desired to insert the active substance into the tumor itself. This may be done in several ways; either the glass tubes may be put into the tumor through a trochar and left there, or they may be placed inside of metal tubes such as represented in the figure, made long or short, thick or thin, and then withdrawn after the desired period of time has elapsed. If the glass tubes are put into the tumor through a trochar and left there, a very prolonged radiation ensues. The emanation disappears, little by little, half of it decaying in slightly less than four days, half of what is left in four more days, etc., so that the tissues are radiated for several weeks continuously, though with progressively decreasing intensity. In certain types of tumors this is by far the most effective method of using radium that I have tried.

Long metal tubes, such as those represented at the right side of Fig. 4, have been used for inserting the radioactive substance into tumors that lie some distance below the skin. A little glass tube containing the emanation lies in the end of the metal tube, close to the sharp point. The two curved instruments in Fig. 4 are of silver and have been used in cases where some filtration was desired. In the thicker one, the hole containing the glass tube has been bored eccentrically, thus giving a much greater filtration on one side than on the other.

Fig. 5 represents the tubes and applicators that are used for intra-uterine conditions, and in cancer of the cervix. The figure also shows the applicators employed in cases where it is desired to hold the radioactive substance at some distance from the skin, as in leukemia and malignant lymphomata.

The small metal cones are used with the steel tubes, to raise them above the surface of the skin, and thus produce uniform radiation over certain areas. These cones hold the steel tubes at distances of 1 cm. to 2 cm. from the surface of the skin. There are various sizes to correspond to the areas of superficial lesions.

The large lead applicator on the brass support is used to give a "distance filtration," of six centimeters or so.

The gauze wrapped around some of the lead applicators serves two purposes: firstly, it cuts off the secondary radiation coming from the surface of the lead, which is not very penetrating, and would produce considerable irritation in the skin; and, secondly, it raises the applicator up from the surface of the skin, thus, according to the inverse square law, reducing the amount of radiation absorbed in the skin as compared with the amount absorbed at a considerable distance below the surface.

It is of the greatest importance in treating malignant disease to be able to vary the penetration of the rays at will, and at the same time to know accurately how penetrating the rays are. The applicators described above provide a very flexible technic with penetration of rays varying within wide limits.

The absorption of rays from radioactive substances by tissues appears to be a very complex phenomenon, and a special article on this subject is in preparation.

Whenever Nature acts, she acts quantitatively as well as qualitatively. Physics deals almost exclusively with quantitative measurements. The importance of estimating phenomena quantitatively, of making exact dosages, is nowhere greater than in the application of the radioactive substances in the treatment of cancer. One must send through the tissues, not simply radiation, but enough radiation to destroy the tumor, and one must be sure to use radiation sufficiently penetrating to reach all the diseased tissues.

The first step in a quantitative estimate of dosage is to measure the quantity of radium, of emanation, or deposited activity, as the case may be, that the applicator contains.

The following paragraphs will be devoted to a description of our measuring instruments. There are three of them:

(*a*) An instrument for accurately measuring the quantity of the radioactive substance in the

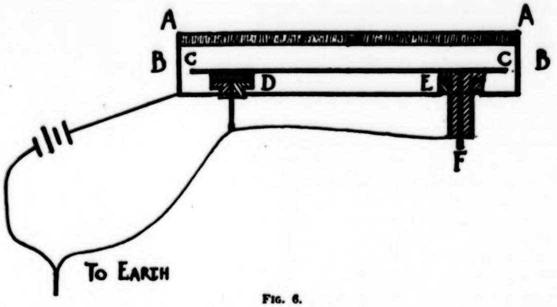


Fig. 6.

applicator, or in a piece of tissue, as the case may be. This instrument is in our laboratory in a room at a considerable distance from the emanation apparatus. The emanation gradually diffuses through the halls and rooms, and leaves behind it on the walls, floor, furniture, etc., the deposited activity, which in time will make delicate and accurate measurements of radioactivity impossible in the part of the building near the emanation apparatus.

(*b*) An instrument for roughly and rapidly estimating the quantity of radioactive substances in tubes and applicators. This instrument is in the hospital in the room in which most of the radium treatments are given, and is used frequently to make sure that the tubes and applicators are in order.

(*c*) An instrument for detecting the presence of radioactive substances. This instrument is a simple form of electroscope, and is used for finding lost tubes that have been thrown away with the bandages, etc., and for ascertaining whether or not the small glass tube previously inserted into the tumor is still intact, and has not been broken.

Fig. 6 represents the apparatus used for accurately measuring the quantity of the radioactive substance in the applicator or tissue. AA is a sheet of lead 50 cm. in diameter and 1.5 cm. thick. It rests on top of a circular brass box, BB, the same diameter as AA, and about 3 cm. deep. A horizontal brass disk, CC, lies in the center of this box, and is insulated from it by hard rubber supports, DE. The box B is charged by joining it to one pole of a battery having an electromotive force of 100 volts or so, and in order to prevent the current from passing from the box B to the disk C through or along the surface of the supports DE, the supports are supplied with metal disks and rods joined to earth as represented. Thus any current starting from the box B along the surface of D would meet this conductor, and pass off to earth without reaching CC.

In order to measure the quantity of a radioactive substance in an applicator, the applicator is placed on top of the lead disk AA. The penetrating gamma rays from this substance then pass through the disk and into the box, where they make the air in the box a conductor of electricity. Under ordinary conditions, air is not a conductor of electricity, but the radium rays have the power of making the air a conductor of electricity, and this phenomenon is called the ionization of the air. When the air is ionized, the current passes across from the box B to the disk C. The greater the amount of the active substance on top of the lead AA, the greater will be the amount of radiation passing through the air in the box, and the greater will be the current flowing from the box to C. This current, under proper conditions, is proportional to the quantity of the radioactive substance on the lead, and is universally regarded as the most satisfactory measure of that quantity.

In order to measure the current flowing from the box to C, one of the supports, E, is perforated, and a wire, F, passes through it and is connected to an instrument for measuring currents of electricity.

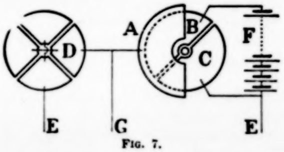


Fig. 7.

The most satisfactory method we have found for measuring the current is to use a variable electrical condenser and quadrant electrometer. A very convenient variable condenser for the purpose has been designed by Dr. Harry Clark, who has charge of the laboratory experiments in our course in Radioactivity.[*] Fig. 7 represents the apparatus. A pile of fixed plates, A, insulated from the rest of the apparatus, is joined to one quadrant D of an electrometer, and also to the wire F in Fig. 6, through which the current from CC comes. Two movable piles of semi-circular plates, B and C, insulated from each other, are mounted on the same support in such a way that they rotate about the axis, and slide in between plates A without touching

[*] Physical Review, July, 1915, pp. 43-45.

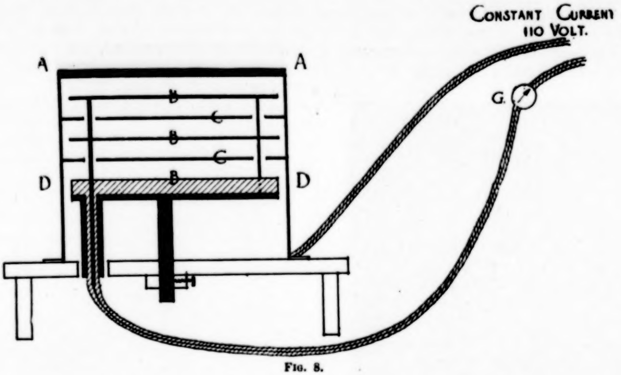


FIG. 8.

them. One set of plates, B, is joined to a battery of constant electromotive force, while the other set is put to earth. Under these circumstances, a rotation of B and C in one direction or the other will cause a charge of electricity to be induced on the plates A; if B and C are rotated at just the right rate, this charge will exactly neutralize the current coming to G from the box of Fig. 6. The rate at which B and C must be turned in order that this neutralization shall take place can be determined by observing the quadrant electrometer D. The plates must be turned just fast enough to keep the electrometer needle at rest. Under these conditions, if the plates at B and C are always turned through the same angle (and stops in the instrument are so placed that this is the case), then the current is inversely proportional to the time required to turn the plates through the angle, and this time is therefore the measure of the current coming from the ionization chamber. In this method, the quadrant electrometer acts simply as an instrument for detecting small charges of electricity.

In order to measure quantities of the radioactive substances in terms of standard units, the apparatus must be standardized. This is done by placing on the lead plate AA of Fig. 6 a sealed glass tube containing a known quantity of radium, and by measuring the ionization current that this produces.

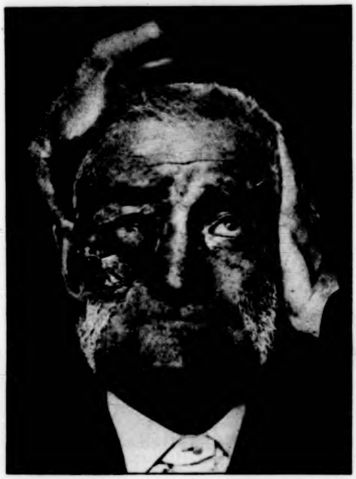
The unit in which quantities of emanation are expressed has by international agreement been defined to be the quantity of emanation that is in equilibrium with one gram of radium element. For practical purposes, this quantity of emanation in a small sealed tube would produce the same penetrating radiation as a gram of radium, for it would have associated with it practically the same quantity of Radium B and C. Consequently, the number of millicuries of emanation in the container, divided by the number of milligrams of radium in the standard, is equal to the ratio of the measured currents when the emanation tube and the radium tube are placed on the lead disk AA, respectively, and these currents are inversely proportional to the two measured times. Hence, practically all that is necessary to do in measuring the quantity of emanation is to divide a certain constant by the measured time.

Fig. 8 represents the instrument in the hospital, used for roughly estimating the strength of the tubes and applicators. AA is a lead disk 30 cms. in diameter and 1 cm. thick, upon which the tube or applicator is placed. BB, etc., are thin sheets of aluminum, supported by metal rods and joined through an insulated copper wire to the galvanometer G. CC are plates parallel to BB, but fastened to the metal box DD, which in turn is joined by an insulated wire to one pole of a battery, or one terminal of an electric light circuit furnishing constant current at 110 volts, the other terminal being joined to the galvanometer as represented.

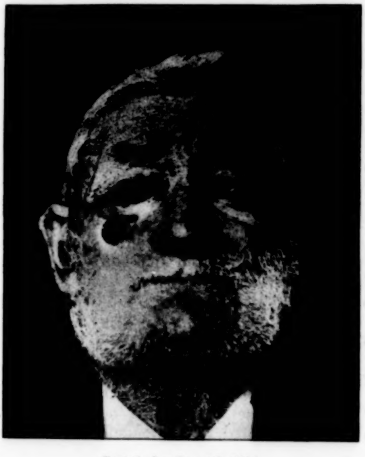
When the applicator containing the radioactive substance is placed on AA, the penetrating rays from it pass through the lead disk AA into the box DD, where they ionize the air. The current then passes from the box through the plates CC, across the air space to the plates BB, and then through the supports and wire circuit to the galvanometer, and thence back to the source of current. The galvanometer deflection is most conveniently read by means of a mirror, lamp and transparent scale. The deflection of the spot of light on the scale measures the current and thus the quantity of activity in the applicator, provided that the deflection of the galvanometer produced by a known quantity of radium has first been obtained.

This instrument is not quite as accurate as the one described above, but is much more convenient and the measurement can be made much more rapidly, for all that is necessary to observe is simply the deflection of the spot of light on the scale.

In order to illustrate the effects produced by the rays on cancer tissue, and, especially, to give an idea of the quantity of the radioactive substance, the time and the filtration required to produce given effects with the above-described methods of treatment, the following cases are cited, chosen from the records of the Huntington Hospital. The history and diagnosis of the disease, and the clinical findings, will be discussed in other sections of the report, by various members of the hospital staff.



Case 1. a.—June 7, 1915.



Case 1. b.—Jan. 12, 1916.

The following cases represent treatments of epidermoid carcinoma. This group of cases is by far the largest of any that we have treated. In selecting illustrations, the most extensive lesions that we have been able to influence favorably have been chosen, so that an idea may be obtained as to the limits of what can be done with the amount of radium at our disposal, namely, 230 milligrams of the element. (Since the period covered by this report, our supply of radium has been increased to about 1 gram.)

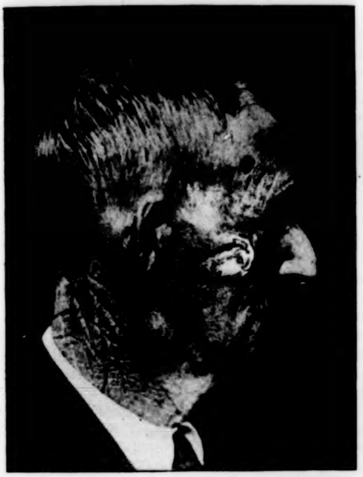
Case 1 represents a recurrence after operation. The pathological diagnosis was epidermoid carcinoma. The treatment given consisted almost entirely of the insertion of small glass tubes containing a few (from 1 to 9) millicuries of radium emanation. The glass tubes remained in place for ten days or two weeks at a time. The treatment began on May 27, 1915, and lasted for nearly a year, at greater or less intervals of time. A practically continuous stream of radiation passed through the tumor for the first six weeks. Two recurrences took place. The figures illustrate the condition of the lesion near the beginning of treatment, on June 7, 1915, and on Jan. 12, 1916. The second recurrence took place after this date, the disease having progressed through into the mucous membrane of the right cheek.

Case 2 represents a condition the pathological diagnosis of which was also epidermoid carcinoma. This lesion was treated almost entirely by the insertion of glass tubes through a trochar into the tissues, giving a prolonged treatment. Treatment began on October 14, 1915, and lasted until May 26, 1916, at intervals varying from one week to two months. The glass tubes contained amounts of emanation varying from 2 to 10 millicuries, and the tubes remained in place on an average of about two weeks. During the latter part of the treatment, the tumor tissue had practically disappeared, and during this period a few treatments were given with steel tubes, each containing from 15 to 34 millicuries, the treatment lasting from one-half to one and one-half hours. The photographs represent the condition of the lesions before and after treatment.

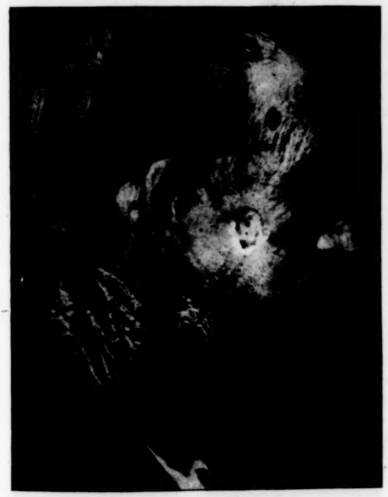
Two fragments were removed from the scar on July 14, 1916, for pathological examination, and Dr. Tyzzer reported that one fragment consisted of necrotic tissue and hyalinized blood clot. The other fragment consisted of an abnormal connective tissue, covered with thick squamous epithelium. Pathological diagnosis: no evidence of new growth.

The condition of these lesions had not perceptibly changed when the patient died of pneumonia on January 24, 1917.

Case 3 represents a series of keratoses widely distributed, some of which, according to pathological report, had definitely degenerated into epidermoid carcinomata. The large tumor growing on the left ear was treated by the prolonged radiation method, the small glass tubes containing a few millicuries of emanation being left in the tissue for two to three weeks. The other lesions were treated by means of the steel tubes with filtration of a few millimeters of air and cotton. The usual length of the steel tube treatment was from one-half to one and one-half hours, and the amount of emanation in the tubes varied from 14 to 47 millicuries. Treatment began on July 7, 1915, and lasted, at intervals of from one week to two months, until January 2, 1916.

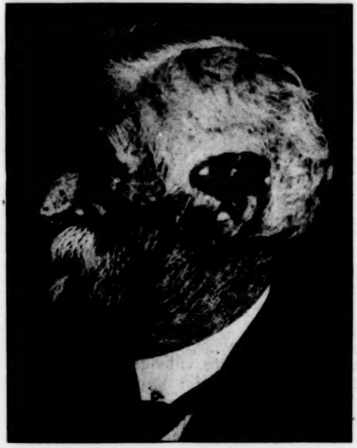


Case 2. a.—Oct. 27, 1915.

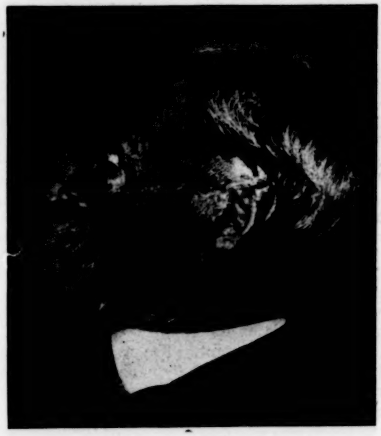


Case 2. b.—July 21, 1916.

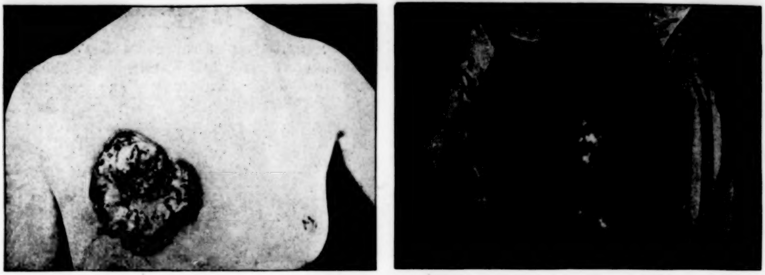
The photographs represent the condition of the lesions on the left hand side of the face before and after treatment. The last treatment of the tumor on the left ear was given on August 24, 1915. During the interval from July 7 to August 24, eight glass tubes, containing a total of 50 6-10 millicuries of emanation were inserted into this tumor, and left in place. Four steel tubes were also used during this period, each for about one hour, containing from 15 to



Case 3. a.—July 7, 1915.



Case 3. b.—Nov. 17, 1916.



Jan. 30, 1914. Sept. 28, 1915.

Case 4.—Pathological Diagnosis: Scirrhus Carcinoma.

35 millicuries of emanation. On July 14, 1916, a specimen was removed from the scar on this ear, for pathological diagnosis. Dr. Tyzzer reported that the specimen consisted of cartilage, in part necrotic, against which lay a layer of fibrino-purulent exudate. Superimposed was a layer of dense, degenerative connective tissue, and at the surface, fibrino-purulent exudate. Pathological diagnosis: no evidence of tumor.

The condition of the lesions in March, 1917, when the patient was last seen at the hospital, did not differ perceptibly from that represented in the photograph of November 27, 1916.

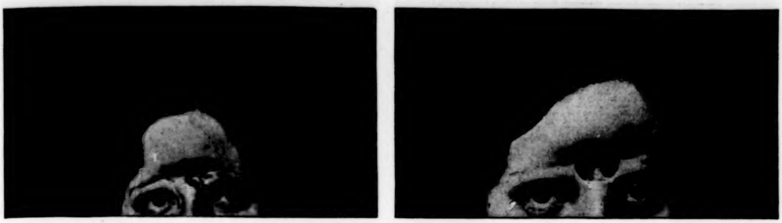
The three cases cited above illustrate what may be termed the prolonged radiation treatment. There are, in general, three important factors entering in a quantitative way into the effects produced by the radiation: (*a*) the amount and distribution of the radioactive substance used, (*b*) the time of exposure to the rays, and (*c*) the filtration. The question as to the effects produced by a small quantity used for a long time, as opposed to a large quantity used for a short time, has not been definitely decided for all cases. In the above treatments, the time element was very large, for the tumors were subjected to continuous radiation for six weeks or two month at a time, the intensity of the radiation being correspondingly small. Thus the time element was enormously increased at the expense of the intensity element. The method has another great advantage also, in that the most energetic of the radioactive rays are used to their fullest extent. The walls of the glass tube being very thin, they absorb very little radiation, which means that a very large percentage of the radiant energy is absorbed in the tissues within a few millimeters of the tube. The distance to which the radiation extends depends to a considerable extent upon the thickness of the glass. In general, the tubes are such that the destructive action on normal tissues caused by the rays, extends to a distance of 7 or 8 millimeters. Under these conditions, epidermoid carcinoma tissue will be destroyed at a considerably greater distance. If it is desired to extend still further the limits of the destructive action, larger doses must be used.

In spite of the fact that the radiation of the tumor lasted continuously for six or eight weeks, no destructive effect was produced on neighboring healthy tissue. A slight erythema, however, appeared for a distance of 2 cms. or so around the lesions.

Cases 2 and 3 above represent the most extensive epidermoid carcinomata that we have been able to destroy so completely that the presence of the carcinoma tissue could not be demonstrated. We have treated a large number of similar cases, and cases of less extensive lesions, which it is unnecessary to describe in detail.

The method of inserting glass tubes through a trochar can be applied only to cases in which the lesion occupies a certain volume. Conditions in which the epidermoid carcinoma tissue is distributed in a more or less thin layer, over a large or small area, must be treated in other ways.

Case 4 represents one of the most extensive lesions of superficial carcinoma that we have treated at the hospital. It illustrates the limit of what we have been able to do with the radium at our disposal. A large number of smaller lesions have been completely removed by the radium treatment. This case demonstrates the effects that can be obtained by a very large number of separate treatments, extending over long periods of time. Radium applications began on February 2, 1914, and the patient is still under treatment. The disease has never disappeared entirely, but the treatment has kept it under control, so that the carcinoma tissue has not extended superficially, and no physical evidence exists that internal metastasis has occurred. During the three years and more that have elapsed since the beginning, the patient has received 64 treatments, with quantities of emanation ranging from a few millicuries up to 142 millicuries. The length of each treatment varied from 1 to 3 hours, and the filtration varied from that due to the glass walls of the emanation tubes themselves, to two millimeters of lead, depending upon the area and thickness of the por-



Nov. 2, 1913. May 28, 1914.

Case 5.—Pathological Diagnosis: Sarcoma.

tions of the tissue to be treated. There has been a marked general improvement in the condition of this lesion, an improvement that has been maintained.

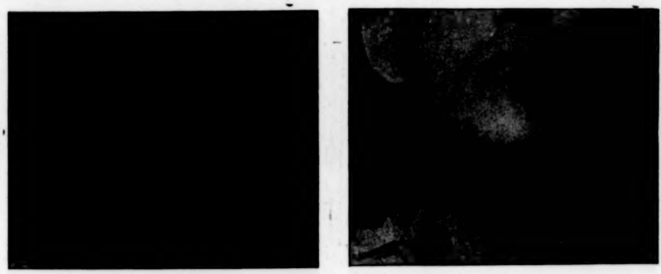
The following sarcoma case illustrates the effects that can be obtained by inserting metal tubes containing radium emanation into the center of the tumor tissue itself. It was one of the earliest cases treated at the hospital, and the satisfactory results obtained are largely due to Dr. Ordway's skill in making the applications. The patient has remained free from signs of recurrence to the present date.

The record contains a number of pathological reports, which give sarcoma with numerous mitotic figures as the diagnosis. The radium applications began on November 28, 1913, and lasted until August 6, 1914. During this period 22 radium treatments were given, the maximum dose recorded being 59 millicuries. The treatments consisted of two kinds: in one the metal tubes were inserted with very small filtration into the tumor tissue itself; in the other, the tubes were laid on the surface, with filtration varying in amount from a fraction of a millimeter of steel, to one millimeter of lead. The length of time varied from one to twenty-four hours. It is probable that the favorable results obtained in this case are due to prolonged treatments, in which the tubes were inserted into the tumor itself.

It is a well-known fact that the large masses of tissue that occur in malignant lymphomata (Hodgkin's disease, lymphosarcoma, etc.) are peculiarly susceptible to radiation. These masses disappear under the action of the rays, but they are very apt to recur; if not in the same place, at other points in the body, and the radiation of one mass has no destructive effect upon masses at a distance. The following case is cited as illustrating the destructive effect that can be produced on this type of tissue by prolonged exposure to the rays from a relatively small amount of radium.

Case 6 represents, perhaps, the largest masses of tissue that we have been able to cause to disappear. The tumor has been subjected to radiation a large number of times between January, 1916, and April, 1917. The doses varied from 31 to 550 millicuries, and the time of exposure from 8 to 48 hours. The total number of millicurie hours during the entire treatment amounted to 93,756. This case is still under treatment.

The method of treating these cases differs fundamentally from that employed in those previously mentioned. Only the penetrating gamma radiation is allowed to pass through the tissues, the filtration being two millimeters of lead, and about two to three cms. of gauze; sometimes, also, the applicator is held on a brass frame at a distance of 6 or 7 cms. from the skin, in order to reduce the skin effect in proportion to the radiation of the underlying tissues. The gamma radiation that goes through this amount of matter carries with it an exceed-



Jan. 9, 1916. April 1, 1917.

Case 6.—Pathological Diagnosis: Malignant Lymphoma (Hodgkin's Disease).

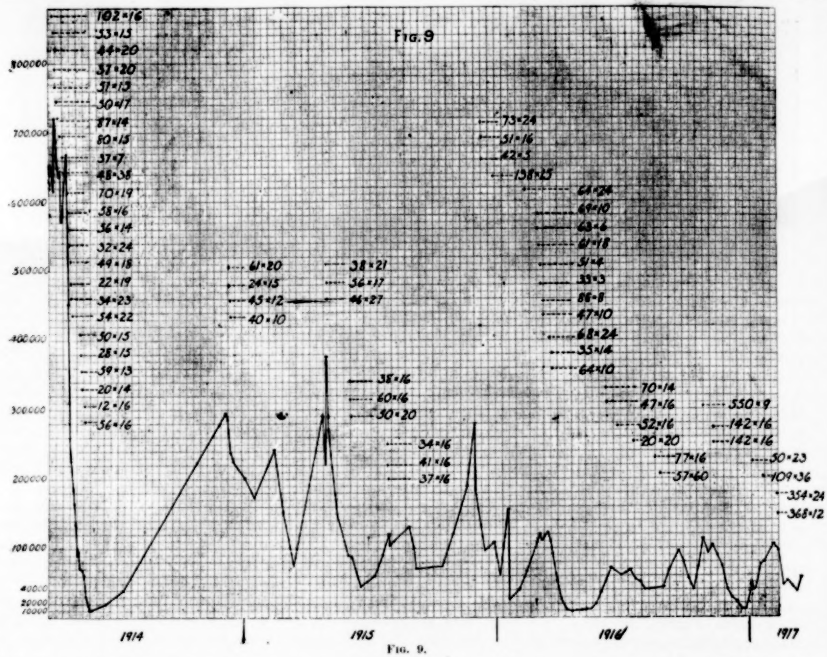
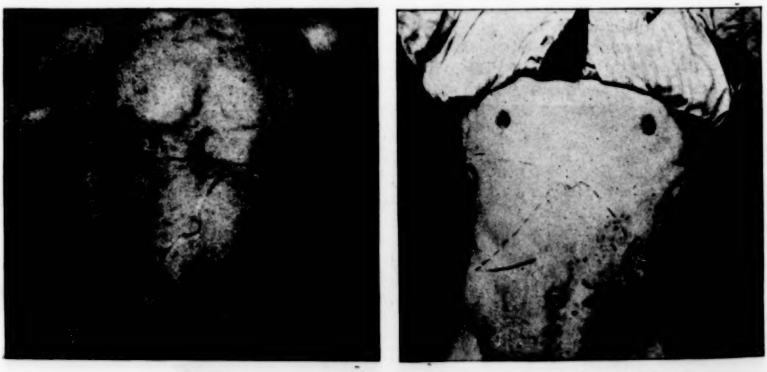


Fig. 9.

ingly small quantity of energy, and it is one of the most extraordinary facts connected with these mysterious substances that such a small quantity of energy can have any appreciable effect on such large masses of living tissues.

As is well known, x-rays produce marked alleviation in cases of myelogenous leukemia, and the fact that radium also has much the same effect was observed in Paris years ago. The best method of treating leukemia with radium is substantially that described above in the case of malignant lymphomata. The emanation tubes, in a lead box with walls about two millimeters thick, are placed at different positions over the spleen, and left there from four to six hours, when they are changed to other positions. The chart in Fig. 9 represents the effect of the radiation on the white cell count of the blood, the



June 4, 1914. March 20, 1914.

Case 7.—Pathological Diagnosis: Myelogenous Leukemia.

figures giving the dosage. The first figure represents the number of millicuries, and the second the number of hours of treatment, respectively. It will be noticed that every series of treatments is followed by a diminution in the white count, even though this is given after a large number of recurrences.

The fact that there is a general decline in the magnitude of the recurrences during the three years in which the patient received treatment is the most hopeful characteristic to be noticed. Attention is called to the fact, however, that larger doses have been used the last few months than before. This chart refers to Case 7, and photographs representing it are also given. These photographs show the diminution produced in the size of the spleen during the first part of the radiation. The spleen has remained small ever since.

Here, again, the size of the effect produced by a small amount of radiated energy is noteworthy. It would take rather delicate chemical tests to discover the chemical change produced by this radiation in so large a quantity of matter.

An exceedingly interesting study of a large number of cases of leukemia treated with radium will be published by Dr. Peabody in a special article on the subject.

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ORTHOARTERIOTONY (A NEW FORM OF PHARMACODYNAMIC ENERGY): THE BIOCHEMIC EXPLANATION OF ITS ACTION, TOGETHER WITH A CONTRIBUTION TO THE INTERPRETATION OF ITS PHYSIOLOGICAL MECHANISM.

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(Summarized Abstract.)

I. THE ACTION OF ORTHOARTERIOTONY.

The action of orthoarteriotony manifests itself thus: if the tension of the radial pulse is too high it becomes lowered, if too low it becomes increased, and from either deviation it becomes reduced to 150 mm. Hg., or, in stricter terms, to a value higher than 140 mm., not surpassing 150 mm.; gradually the blood-pressure becomes more and more stable, whereby vasomotor tranquillity at a normal blood-pressure level is restored.[1] Such was the action of iodine, constantly recurring in the same manner, when used in accord with the following description, as observed in 98 out of 100 cases of various forms of insanity, during the last 4 years treated by the method hereinafter described.

II. THE DYNAMIC FACTOR OF ORTHOARTERIOTONY.

Schematically, equal amounts of one and the same chemical substance may be conceived as producing different medicinal action, depending upon whether it is chemically engaged by or reacts upon one or another of the constituents of the blood or the tissues after it has been resorbed. Induced by such theoretic anticipation, the author formulated the problem to find experimentally a chemical complex containing iodine and endowed with such chemical affinities that, by its internal use, after resorption, iodine must be combined with or chemically react upon protein in the blood or in the tissues.

With the said purpose in view, the author endeavored to produce a molecular complex of tannin containing iodine, and, after numerous experiments, conducted at intervals during a sequence of years, he obtained as a result a product in which the total amount of iodine and tannin engaged in reaction was taken up in soluble form without any insoluble by-product being precipitated.[*]

The product thus resulting does not react for free iodine (with starch or chloroform), and does not contain any inorganic base. It can be identified by the fact that a solution of it takes up to a perfectly clear and transparent fluid an amount of nitrate of silver corresponding to 9-10 of the equivalent of the amount of iodine contained in it.[†]

The chemical constitution of this iodine-containing complex is not known with certainty at present, but it can always be made to contain a definitely known quantity of iodine and tannin; for instance, 1:4, or another relation; it may be elaborated into suitable form for intravenous injection or for use subcutaneously or per os.

The complex thus described is exactly the dynamic factor which at the clinical dynamic tests carried on by the author revealed the action of orthoarteriotony in the year 1909,[‡] confirmed in the years 1913-1917 by the results of 98 out of 100 cases of various forms of insanity treated with this dynamic factor.[§]

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[*] The author's aim to attach organic iodine *in sanguine* and action of such is his reason for describing the iodine-tannin complex used for this purpose.

Numerous products of different procedures containing iodine and tannin, described by various authors, have been used for medicinal purpose since the middle of the previous century; if these products contain organic iodine *in vitro*, or not, has been the subject of investigation by several writers; but that the idea of organic iodine *in sanguine* should have been actualized has not been purported by any writer. Regarding some such iodine complexes, see: Lyon et Loiseau, "Formulaire thérapeutique," Paris, 1903; Power and Sheddon, "The Chemical Character of So-called Iodo-tannin Compounds," Pharm. Journ., xiii, London, 1901; Lafay, L., "Sur la constitution et l'activité des peptones iodées," Bull. Génér. de Thérapeutique, clxi, Feb. 15, 1911; and other authors.

[†] The nitrate of silver test, as above, is not described or mentioned previously by writers upon the subject of iodine-tannin products. Guillermond's iodo-tannin (Journ. de Pharm. et de Chimie, 3me. Sér., xxiv, 1854) gave *immediately* on admixture of nitrate of silver a precipitate of iodide of silver, when a sample of this preparation, bought in a drug store, was tested by the author exactly as mentioned above. As is well known, soluble iodides and hydriodic acid give precipitate of iodide of silver immediately on admixture of nitrate of silver.

[‡] A preliminary report on this observation, made in America, 1909. See "Svenska Läkare-Sällskapets förhandlingar," Feb. 8, 1910.

[§] In Stockholm Hospital for Insane, with consent of chief physician, Dr. B. Gadelius; in Säter Hospital for Insane, with consent of chief physician, Dr. E. Göransson, and his successor, chief physician, Dr. A. Granholm.

III. THE BIOCHEMIC EXPLANATION OF ORTHOATERIOTONY.

Iodide of sodium does not produce the action which characterizes orthoarteriotony. This fact supports, beyond a possibility of doubt, the conclusion that iodine, after resorption of the dynamic factor described (II) has taken place, does not react directly upon carbonate of sodium in the blood to form iodide of sodium, and does not act as such when orthoarteriotony is manifested, but must act through the medium of some other intervening chemical reaction. It follows that first iodine must be taken up by or react chemically upon protein or some other organic molecule in the blood or in the tissues, before it is transformed into iodide of sodium and eliminated as such.

The chemical reaction thus conceived and proved constitutes the proximal biochemic explanation of the action of orthoarteriotony, which is capable of being formulated upon the basis of the author's observations and upon the strength of the facts which he presents in the thesis of which the present article is an abstract. By this biochemic explanation the action of orthoarteriotony is distinguished as caused by a form of energy which is entirely distinct from that which is revealed by the action of iodine, when, after resorption, it directly reacts upon carbonate of sodium[2] to form iodide of sodium and acts as iodide of sodium. Orthoarteriotony is a form of organic iodine action; anorganic iodine action does not produce orthoarteriotony.

IV. THE PHYSIOLOGICAL MECHANISM OF ORTHOARTERIOTONY.

In view of theoretical arguments and experimental findings, the action of orthoarteriotony is interpreted as the result of:

(*a*) Removal of the cause of the blood-pressure disturbance in the cases considered, in that the blood ceases to be charged with chemical vasomotor irritaments as sequel of the action of iodine when, after resorption, it is taken up by or chemically reacts upon protein or another organic molecule in the blood or in the tissues before it is ultimately transformed into iodide of sodium.

(*b*) The automatic regression of the vasomotor mechanism into its normal adjustment (orthoarteriotony) as a sequel to the removal of the cause of the preëxisting blood pressure disturbance (dysarteriotony).

High degree of probability in favor of this interpretation is adduced by the facts presented in the author's thesis.

V. CHARACTER OF ORTHOARTERIOTONY.

In view of the preceding paragraphs (I-IV), the pharmacodynamic action described can be characterized briefly as aetiotropic[3] orthoarteriotony through organic iodine action.

VI. QUESTIONS AS YET UNDETERMINED.

The interpretation of the action of orthoarteriotony, which is presented in the preceding paragraphs, leaves undecided the question as to where the freeing of the blood by chemical vasomotor irritaments is brought about:

(*a*) Whether directly in the blood by iodine neutralizing substances, foreign to the blood, acting as vasomotor irritaments;

(*b*) Or if chemical vasomotor irritaments cease to charge the blood as before, as a sequel to the modifying action of iodine upon the metabolism, produced in the cells everywhere in the tissues;

(*c*) Or if iodine produces its action through the intermedium of some one special detoxicant organ.

The last-mentioned alternative seems more probable, but the question is not brought under discussion in this thesis, as the author has not as yet observed new facts of such a nature that by their aid the question last alluded to can be definitely decided.

VII. NOT EVERY SUBSTANCE FOREIGN TO THE BLOOD ACTS AS A VASOMOTOR IRRITAMENT.

Removal from the blood of vasomotor irritaments, as a result of organic iodine action, does not imply that every substance foreign to the blood is being eliminated as result of iodine action. Substances foreign to the blood may be present in the blood without necessarily causing vasomotor disturbances. Several substances foreign to the blood, if present in the blood, alter the blood-pressure and produce dysarteriotony; others, on the contrary, in a given case, do not.

VIII. THE PHARMACOLOGICAL PLACE OF ORTHOARTERIOTONY.

Orthoarteriotony belongs to the forms of iodine action that are peculiar to iodine as such, understood as distinct from action of iodides.[4] The feature of precision in the manifestations of orthoarteriotony, as well as in the technic which brings it about, serves well the purpose of emphasizing and sharply defining the difference between organic iodine action and anorganic or iodide action.

The orthoarteriotony cannot be referred to the same category as the organotropic[5] blood-pressure modifacients (such as digitalis, adrenalin, nitroglycerin, etc.), which, by virtue of direct action upon a distinct function of the vasomotor mechanism, either stimulate or depress the heart or the blood-vessel nerve apparatus.

IX. METHOD OF MEASURING THE TENSION OF THE PULSE IN THE INSANE.

For the purpose of investigating the vasomotor unrest in the insane, and the action of orthoarteriotony, the sphygmometer is to be used as the instrument of measurement, because it is the instrument which is constructed upon the right principle for the purpose of measuring the tension of the radial pulse, *i.e.*, the maximal systolic blood-pressure in the radialis artery.[*]

The essential feature of the sphygmometer method is that the radialis artery gets compressed by means of a pelotte with small compression surface. It must be about the same size as the palpation surface of the index finger, and its pressure must be applied directly over the artery at the point where its pulsations are felt as most superficial. By these precautions all disturbing influence of vascular or muscular reflexes upon the reading of the blood-pressure value on the scale may be completely excluded.

In measuring with the sphygmometer, if proper technical rules are carefully observed, the possible error of observation is less than ten millimeters. This conclusion is based upon the author's experience obtained in making about 40,000 measurements of the tension of the pulse in the years 1904-1917.

X. INCOMMENSURABLE FEATURES OF OTHER METHODS OF MEASUREMENT.

Blood-pressure measurements, by ordinarily used methods other than the syhygmometer, cannot be used in making controlling tests of the vasomotor unrest in the insane and the action of orthoarteriotony, and this for forcible reasons which may be briefly stated as follows:

(*a*) The sphygmomanometer method, according to Riva-Rocci, or any modification of this method (compression of the upper arm by a cuff of 5-16 cm. breadth), cannot be used for the purpose under consideration for the reason that by this method it is not possible to measure the maximal systolic blood pressure in the radialis artery in the insane, as in place of it is obtained the cipher value of a fraction of the blood-pressure in the brachialis artery.

Owing to the high degree of lability of the blood pressure in the vast majority of the insane, the cipher value which is obtained in measuring with the Riva-Rocci method expresses the residual blood pressure which remains in the brachialis artery after withdrawal of a greater or smaller portion of the actual blood-pressure as effected by the technic of this method of measurement. The change in the blood-pressure is brought about through the influence of reflexes, vascular or muscular or both, which are elicited by the cuff compressing the arm by virtue of the irritation produced upon the soft parts of the arm submitted to pressure by this method.

If, notwithstanding this objection, the attempt is made to measure the tension of the pulse in the insane by means of a sphygmomanometer with the cuff 15 cm. broad, the error of observation is more than 40 mm. Hg. in the acute and subacute cases, and the deviation from the actually existing maximal systolic blood-pressure may amount to 120 mm. Hg., according to the author's observations; possibly the error of observation may attain still higher cipher value[†] in some exceptional case.

(*b*) Blood-pressure experiments on animals, according to ordinary laboratory method, cannot be used in making controlling tests of the action of orthoarteriotony by organic iodine action, for the following reasons:

During the experiment in the laboratory the animal is in a state of narcosis and experimental shock while the blood-pressure test is being performed. In consequence, the blood-pressure of the animal is low, more or less approaching the collapse pulse. The cause of this blood-pressure disturbance in the animal experimented on is of quite a different nature from the cause of the vasomotor disturbance in an insane person *in natura*. Thus, the blood-pressure of the experiment animal presents a problem incommensurable with that of an insane person *in natura*, whose blood-pressure disturbance, for the greatest part, is caused by vasomotor irritaments in the blood derived from anomalies of metabolism and secretory disturbances. Conclusion from the former upon the latter will prove fallacious.

XI. FORMER ATTEMPTS TO STUDY THE BIOCHEMIC REACTIONS OF IODINE AFTER RESORPTION, BY EXPERIMENTS IN VITRO.

The biochemic explanation of orthoarteriotony, as depending upon chemical interaction of iodine and protein or other organic molecules in the blood or in the tissues, cannot be controlled or determined by laboratory tests *in vitro*, such as previously attempted. Experiments with hen albumen or blood serum and iodine *in vitro* have been made and repeated during the last 70 years without any practical purpose attained as far as the question under discussion is concerned.

Such findings as have been made have always been capable of being interpreted in various ways and have resulted only in hypotheses[6] which remain unproven.

XII. SUPPLEMENTARY EVIDENCE FROM THERAPEUTIC OBSERVATIONS.

Observations of therapeutic effects may be used to supplement and further to support the action of orthoarteriotony as depending upon organic iodine action and as contradistinct to anorganic or iodide action.

XIII. VASOMOTOR TRANQUILLITY AT NORMAL BLOOD-PRESSURE LEVEL MAY BE MAINTAINED THROUGHOUT THE WHOLE COURSE OF EVOLUTION OF ALMOST ANY[‡] CASE OF INSANITY, IF REQUIRED.

Examples of vasomotor unrest in the insane and of orthoarteriotony, by virtue of organic iodine action, are represented by the accompanying diagrams.

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[*] This statement does not refer to any special signature or trademark, but it refers to any instrument constructed with precision upon the principle of the sphygmometer.

[†] A fuller discussion of this subject and a presentation of facts in support of the statements above are found in the author's article: Clinical Arteriotonometry (soon to appear in print).

[‡] Exceptions make a small proportion of all cases tested.

By the use of iodine, as described in the author's thesis, it is within the power of the physician to cause the evolution of symptoms of the insane to develop throughout its whole course in a state of vasomotor tranquillity at normal blood pressure value, if in a given case he chooses to do so. The therapeutic advantage of this measure is not discussed in this thesis. Orthoarteriotony, by virtue of internal use of iodine "lege artis," is obtained as surely as anesthesia is obtained by proper use of ether or chloroform, according to rules of the art.

XIV. EXPLANATION OF THE FOLLOWING BLOOD-PRESSURE DIAGRAMS.

⊙ Signifies the cipher value of the tension of the radial pulse under the influence of organic iodine action.

● Signifies the cipher value of the tension of the radial pulse without influence of organic iodine action.

It is to be observed that, inasmuch as the diagrams express centimetric and not millimetric units, the cipher value of 150 mm. represents all values that are higher than 140 mm., but not higher than 150 mm.

If, instead of the present, a diagram of millimetric units were to be constructed, then orthoarteriotony would not be represented by a straight horizontal, but a zigzag line in the interspace between the lines of 140 and 150 mm.

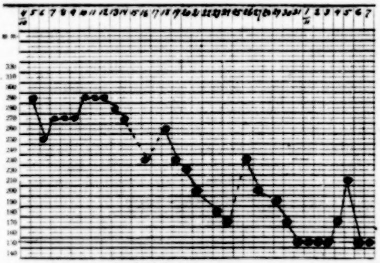

Diagram 1. Mania.

No. 624, Säter Hospital; man, 38 years, entered the hospital July 29, 1915; onset of the disease 12 years before entry, periodical evolution.

Present symptoms. Hilarious, cannot keep quiet nor keep his mouth shut; stream of words swift, voice loud, gesticulates, swears, screams, threatens; spiteful, discontented, disturbs the others, is lodged in the department for the violently insane and dangerous.

Tension of radialis artery. High degree of vasomotor unrest at high hypertension level.

Treatment. *Organic iodine action* from October 19, 1916, to January 20, 1917§ together with treatment as otherwise indicated.

Development. *Orthoarteriotony* from October 31, 1916; from middle of December quiet, obedient, works, helpful; from December 1, 1916, transferred to the wards for half-quiet patients.

No. 727, Säter Hospital; man, 70 years, entered the hospital May 20, 1916; onset of the disease 6 months before entry; no previous attack of mental disease.

Present symptoms. Sentiment changeable, mostly depressed, persecutory ideas, hallucinations of sight and hearing, believes himself to be accused of crime and that he shall have to meet capital punishment; weeps, memory impaired, can retain a number containing 3 ciphers, not a number containing 4 ciphers; motor control.

Tension of radialis artery. Vasomotor unrest at hypertension level.

Treatment. *Organic iodine action* June 13 to September 10, 1916, together with treatment as otherwise indicated.

Development. *Orthoarteriotony* from June 30 to the day of leaving the hospital; from early in September good mental equilibrium; no hallucinations, no false ideas, memory improved, can retain a number containing 5 ciphers; has good insight concerning his having been mentally ill; discharged from the hospital September 10, 1916, cured.

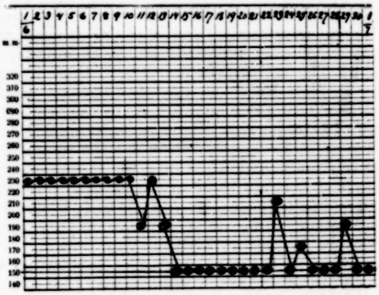

Diagram 2. Melancholia in Senium.

No. 482, Säter Hospital; man, 68 years, entered the hospital October 16, 1913; onset of the illness 4 months before entry; no previous attack of mental disease.

Present symptoms. Sentiment changeable, sometimes glad, sometimes depressed; without foundation accuses his wife of infidelity; has acted in a confused manner and with poor judgment in business matters; squandered his property; is angry with relatives; preaches, sings, weeps; memory impaired; often noisy and turbulent.

Tension of radialis artery. High-grade vasomotor unrest at a high hypertension level, during more than a year continuing to be of about the same character as the diagram indicates.

Treatment. *No* organic iodine action; *no* orthoarteriotony.

Development. Dementia, no spontaneous change in the character of the pulse tension.

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§ This case is an exception to the author's other cases hitherto treated by this method in so far as the patient has a vitium cordis and albuminuria; the treatment has not been intense, as it is not yet decided whether such complication is a contraindication to orthoarteriotony treatment.

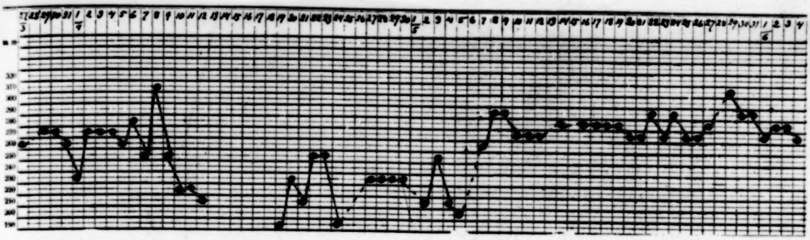


Diagram 3. Dementia Senilis.

No. 4198, Stockholm Hospital; man, 21 years, entered May 26, 1913; onset of the disease a few days before entry; no previous attack of mental disease.

Present symptoms. Quiet, lucid, but very slow in speech and general motility; answers questions briefly, in few words, little more than "yes" and "no"; looks astonished, embarrassed; knows hardly what to say or to do; reconvalescent.

Tension of radialis artery. Vasomotor unrest at low hypertension level.

Treatment. Organic iodine action from August 8 to October 14, 1913, together with treatment as otherwise indicated.

Development. Orthoarteriotony from August 8 to the day of leaving the hospital; discharged October 19, cured.

No. 3244, Stockholm Hospital; woman, 21 years, entered the hospital June 10, 1908; onset of the disease 3 months before entry.

Present symptoms. Stupor, mutismus, stolid face; needs to be helped in everything, must be fed by the attendants.

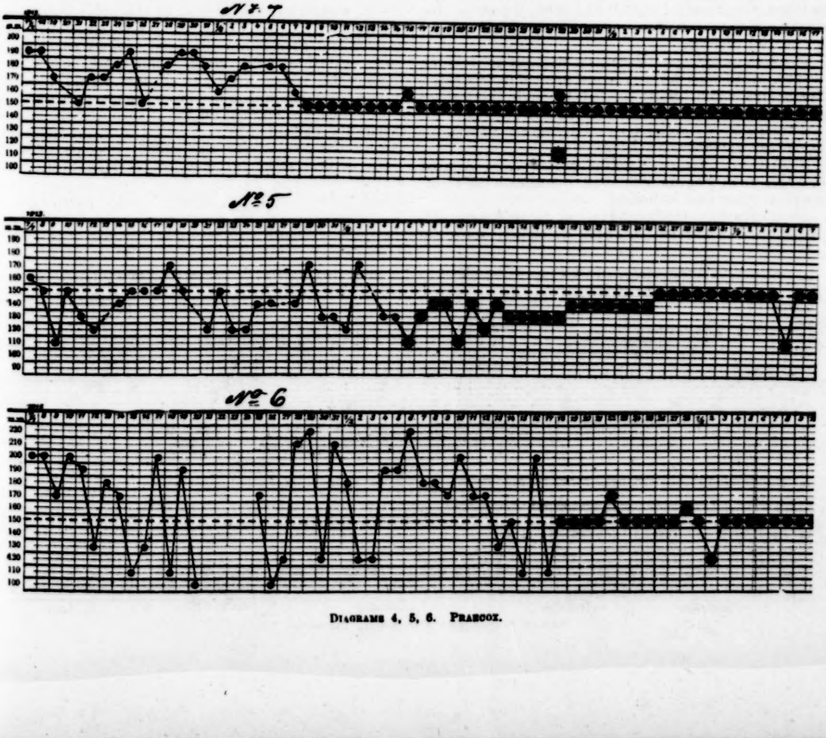
Tension of radialis artery. Vasomotor unrest in hypotension, approaching the normal blood-pressure level.

Treatment. Organic iodine action from August 6 to October 5, 1913, together with treatment as otherwise indicated.

Development. Orthoarteriotony from August 26 to October 5, 1913; no change in the mental symptoms.

No. 481, Säter Hospital; woman, 45 years, entered the hospital January 5, 1914; onset of the disease two years before entry.

Present symptoms. Depression, anguish, com-



Diagrams 4, 5, 6. Praecox.

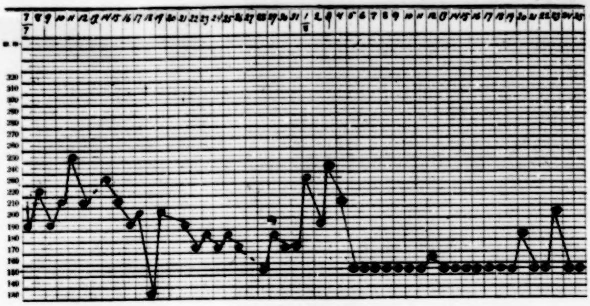


Diagram 7. Praecox.

plaining, sobbing talk, psychomotor agitation, persecutory ideas, hypochondriac ideas, sense perception of being transformed.

Tension of radialis artery. Vasomotor unrest with large changes between hypertension and hypotension values.

Treatment. Organic iodine action from February 18 to March 11, 1915, together with treatment as otherwise indicated.

Development. Orthoarteriotony from February 18 until the day of leaving the hospital. From beginning of March more tranquil as regards sentiment and mobility; the treatment was discontinued owing to the transference of the patient to another hospital on March 11, 1915.

No. 4161, Stockholm Hospital; woman, 20 years, entered the hospital April 23, 1913; onset of the disease 2 months before entry; no previous attack of mental disease.

Present symptoms. Face pale without expression, stupor, mutismus, negativismus, muscular tenseness, flexibilitas cerea; must be fed through the rubber tube, needs to be helped in everything.

Tension of radialis artery. High-grade vasomotor unrest at hypertension level.

Treatment. Organic iodine action from August 3, 1913, until February 2, 1914, together with treatment as otherwise indicated.

Development. Orthoarteriotony from August 24, 1913, until February 2, 1914, on which date the patient was discharged from the hospital and removed to a private home; no improvement in psychic symptoms having yet occurred; later on improvement developed; she is now (1917) well and able to attend to her regular occupation.

No. 3673, Stockholm Hospital; man, 35 years, entered the hospital September 13, 1911; onset of the disease 2 years before the entry, no previous attack of mental disease.

Present symptoms. Short, tranquil periods alternate at regular intervals with more prolonged periods of unrest, increasing to outburst of violence with hallucinations and false ideas; during the periods of the diagram, when the tension of the pulse approaches the normal value (*i.e.,* 28-6, 11-7, 28-7, 11-8, etc), the patient is quiet and lucid. When, thereafter, the tension of the pulse increases, unrest soon begins to set in, which gradually increases and grows into the most violent psychomatoric agitation with vivid, changeable hallucinations, false ideas of frightful, terrorizing nature, intense anguish and muscular tenseness; during the days which are marked on the diagram with parenthesis, the patient must be tended to in an isolation cell in the section for the violent insane; then it takes several powerful men to restrain him from violent acts and to keep him down in bed; between-times (days not marked with parenthesis) he resides in a private apartment in the department for quiet patients and occupies himself with sloyd

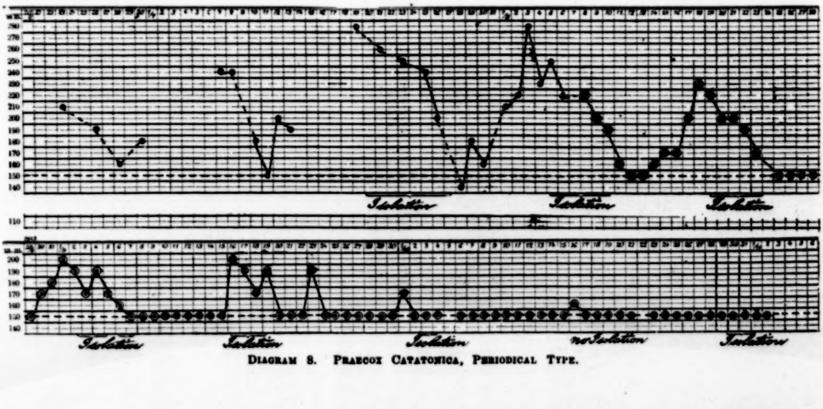


Diagram 8. Praecox Catatonica, Periodical Type.

work, reading—even with scientific problems of high order; or he goes to the hospital chapel, sits at the piano and plays classical music; on few of his most tranquil days he receives visits by friends and some days he can even make visits to relatives in the city.

Tension of radialis artery. High-grade vasomotor unrest with a periodicity which exactly follows the periodicity of the psychic symptoms described above; at regular intervals of 14-16 days the tension of the pulse gets spontaneously approximately normal, *i.e.,* 150 mm., or near this figure, and simultaneously psychic quiet and lucidity set in; the following day the tension of the pulse begins again to increase and it increases more and more on the subsequent days; when the tension of the pulse has attained 200-230 mm. the unsettling of the psychic synthesis begins with increasing unrest which, some days later, after the tension of the pulse has reached its highest value, 280 mm., attains its maximum of violence and remains violent during the next following days, while the tension of the pulse begins to decrease; between the highest points of the blood-pressure (19-7, 3-8, 18-8, etc.) the alternating periods are of equal duration—about 15 days.*

Treatment. Organic iodine action from August 8 to November 2, 1913, together with treatment as otherwise indicated; the iodine treatment was discontinued from November 3, 1913, for incidental reasons.

Development. Orthoarteriotony from September 24, 1913; the vasomotor unrest became gradually reduced, with intensity maximum still recurring at regular intervals, coinciding with the preceding periodicity; the quiet periods became gradually lengthened, the violent periods gradually shortened; the restraint in the isolation cell, which before the orthoarteriotony treatment used to have a duration of 7 days or more, was now gradually shortened, and on October 16 it was found safe to dispense with it entirely. In the condition of the patient a further progressing improvement entered subsequently. On the 15th of July, 1916, he was discharged from the hospital cured, and he has since resumed the practice of his scientific technical profession.

No. 743, Säter Hospital; youth, 17, entered the hospital July 18, 1916; onset of the disease one year before entry; no previous attack of mental disease.

Present symptoms. Stupor, mutismus, stolid face without expression; can eat without help, must be helped in everything else.

Tension of radialis artery. Vasomotor unrest at hypotension level.

Treatment. From January 9, 1917, *organic iodine action,* together with treatment as otherwise indicated.

Development. Orthoarteriotony from January 10, 1917; the treatment still continues (June, 1917); the patient can move slowly about, can help himself in everything and can do simple needlework; he is still mutistic, but his face expresses interest and ordinary feeling in relation to his surroundings; he is gaining in weight, and the author considers his prognosis to be hopeful as far as the present attack is concerned.

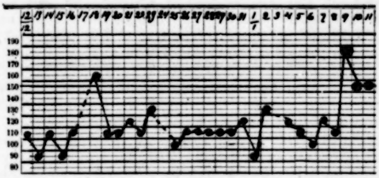


Diagram 9. Praecox.

No. 584, Säter Hospital; man, 26 years, entered the hospital March 20, 1915; onset of the disease two years before entry; no previous attack of mental disease.

Present symptoms. Sentiment apathetic, incidental outbreaks of wrath from inner motives; not susceptible to impressions from the environment; persecutory ideas, suspects poison to have been mixed in his food; thinks he has been able to read other persons' thoughts; motor unrest; jumps out of bed often; scoffs and swears under influence of his false ideas.

Tension of radialis artery. High grade of vasomotor unrest at hypertension level of 230-240 mm. Hg., sometimes higher or lower, remaining throughout 1915-1916 and continues yet (in February, 1917).

Treatment. No organic iodine-action, *no* orthoarteriotony; treatment as otherwise indicated.

Development.. Dementia; no spontaneous change of the blood-pressure.

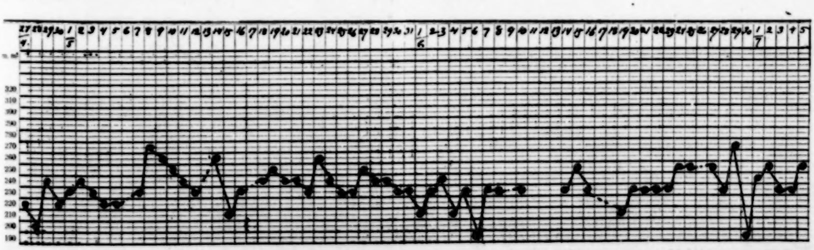


Diagram 10. Praecox.

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* Details of the vasomotor diagram vary greatly in different cases of praecox of periodical type. Such remarkable regularity and coincidence between the periodicity of the psychotic symptoms and the vasomotor manifestations as the case above presents has not as yet been observed by the author in another similar case.

But in all cases of periodical praecox, hitherto observed by the author, vasomotor tranquillity at normal blood-pressure-level has developed simultaneously with the development of a remission in the psychotic symptoms.

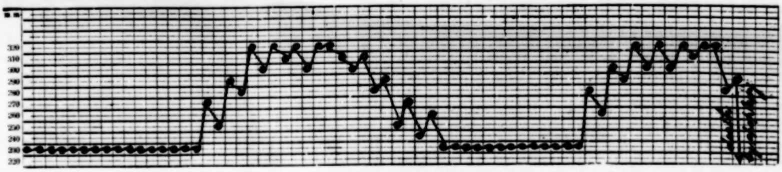

Diagram 11. Dementia Organica. Apoplexy.

No. 4226, Stockholm Hospital; man, 52 years, entered the hospital October 2, 1913; onset of the disease three months before entry; no previous attack of mental disease.

Present symptoms. Apoplectic stroke twice during the time, which is represented on the diagram.

Tension of radialis artery. The diagram gives a condensed schematic representation of the development of the blood-pressure during the last four months before death; the apoplectic strokes occurred during the latter part of the rise of the blood-pressure to about 290-320 mm. Hg.

Development. Died February 27, 1914; at the post-mortem examination recent large cerebral hemorrhage; several sections of the brain discolored from previous, smaller blood-extravasations.

No. 748, Säter Hospital; man, 28 years, entered the hospital September 2, 1916; four months before entry he had killed a man by a blow from a hatchet and shot a young woman with his revolver; transferred to the hospital by order of the court for observation and report as to his mental condition.

Present symptoms. The patient, who is a merchant of good family, good education, and good social relations, is not insane in the ordinary sense, but suffers from neurasthenia.

Tension of radialis artery. Vasomotor unrest at hypertension level; the lability of the pulse expresses itself also in large, often occurring changes in the frequency, generally varying between 80 and 120, most often about 100; at occasions, which recur at intervals quite often, it is enormously increased, so that sometimes it is difficult to count the frequency. For instance, on October 14, with a tension of the pulse of 250 mm., the frequency was 148; Oct. 19, with a tension of 250 mm., the frequency was 168; Oct. 20, with a tension of 280 mm., the frequency 160; and Oct. 29, with a tension of 250 mm., the frequency was 136.

At so high a frequency, in connection with so high a blood-pressure as, for instance, on October 19 and 20, the pulse makes to palpation the impression of a vibrating cord and gives one the impression of clonic cramp in the artery. As already mentioned, this phenomenon was observed four times from October 14 to 29.

Development. No spontaneous relief in the blood-pressure; on January 20, 1917, the city court of Stockholm sentenced No. 748 to death for murder in the first degree; the patient has appealed to the superior court and, upon the basis of the medico-legal report,† requested that the crime diagnosis of the city court be changed to manslaughter.

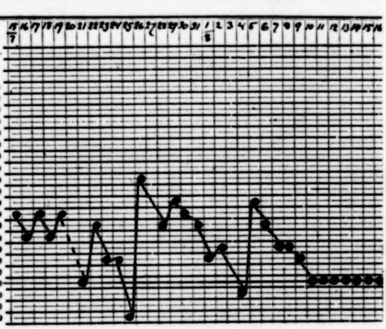

Diagram 13. Dementia Paralytica.

No. 4209, Stockholm; man, 46 years, entered the hospital June 20, 1913; onset of the disease one month before entry; no previous attack of mental disease.

Present symptoms. Confusion of ideas, high sentiment alternating with sorry mood and weeping; wants to make speeches, make up rhymes, improvise poems, recite; high-grade motor unrest, dis-

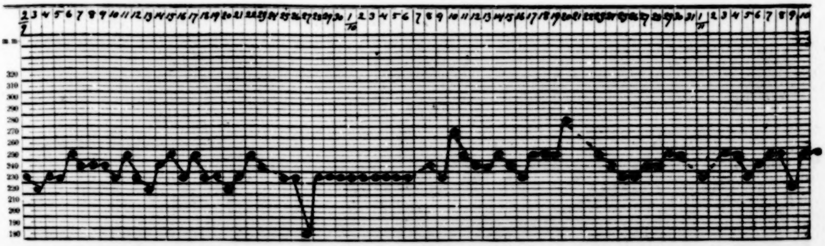

Diagram 12. Neurasthenia.

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† The report of chief physician, Dr. Granholm, is an official document which will be printed in "Meddelanden fran Kungl. Medicinalstyrelsen, Rättspsykiatriska rettatander avgifna ar 1916.

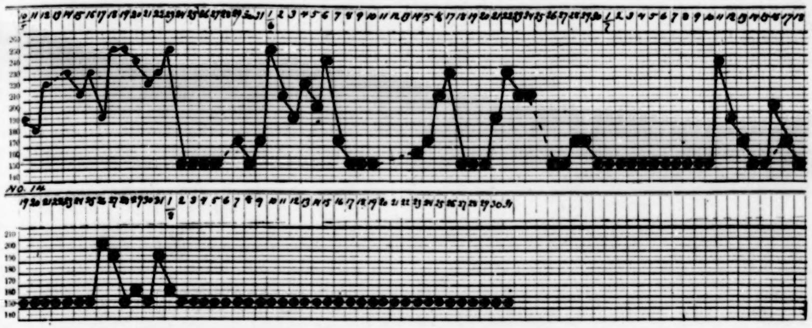


DIAGRAM 14. INSANIA EPILEPTICA IMBECILLITAS.

turbances of speech (lues in the anamnesis), stale pupils, patellar reflex abolished.

Tension of radialis artery. High grade of vasomotor unrest at hypertension level.

Treatment. Organic iodine action August 7 to September 24, 1913, together with treatment as otherwise indicated.

Development. Orthoarteriotony from August 10 until leaving the hospital; from end of August improvement, which progressed rapidly; in third week of September lacking insight in his illness, otherwise free from psychotic symptoms; after leaving the hospital he had been able to manage his banking business; died 1916.

No. 99, Säter Hospital; youth, 15 years, entered the hospital April 10, 1912; from birth mentally below ordinary standard.

Present symptoms. From the age of 11 years epileptic attacks, morally defective, has no idea of right or wrong.

During his stay in Säter Hospital the patient has taken bromide of sodium from 3 to 6 grams daily; with this amount of bromide of sodium the epileptic seizures have varied from one to nine per month; in May, 1915, bromide of sodium was omitted, and this month the number of seizures was 14, of which 11 occurred in the night time and 3 in the daytime.

Tension of radialis artery. High grade of vasomotor unrest at hypertension level.

Treatment. Organic iodine action from May 24 to Aug. 31, 1915; *no* bromide.

Development. Orthoarteriotony from Aug. 1 to Aug. 31, 1915; after the first dose of iodine the tension of the pulse decreased from 250 mm. to 150 mm. Hg., but every time an epileptic seizure occurred the blood-pressure increased the same day or next, following to 250 mm. or a lower hypertension value; in a measure, as the number of the seizures decreased, the tension of the pulse became more stable; the number of seizures amounted in May to 14, in June 9, in July 8, in August 0. *In August orthoarteriotony and no seizures,* although no bromide was used. This case has given impetus to further experimental work, which possibly may bring future result.

NOTE. The preceding article is a summarized abstract of a larger thesis on the same subject, under the same title, which will soon be ready to be printed. In it all the facts are presented which are necessary for the purpose of substantiating the statements made above.

The leading aim of my thesis is to present and describe the facts of *orthoarteriotony, a form of medicinal action which has not been observed and is not described in the pharmacological literature up to the present.* In the thesis the biochemic explanation of this form of action is more fully discussed, and facts are presented which, to a high degree of probability, support the physiological interpretation of its mechanism, as offered above.

Besides, a full description is given of all technical details, chemical and clinical, which will enable every physician to avail himself of the action of orthoarteriotony, if he chooses to do so.

It is the author's intention, on a future occasion, to present still another series of facts concerning orthoarteriotony in relation to mental diseases. Thereafter, it may be possible to begin to discuss the significance of orthoarteriotony for the study of the mechanism of certain forms of mental diseases and also to foreshadow the prospective value of orthoarteriotony in relation to therapy of insanity and to mental economy.

The problems which I discuss under the title of orthoarteriotony belong to the frontier territory between the provinces of medicine and chemistry. In these problems, medical questions are so intimately interwoven with chemical questions that after years of labor, I am convinced of the impossibility of solving these problems strictly within the province of either chemistry or medicine separately. Attempt to distinguish organic iodine action from inorganic iodine action by ordinary methods of analytical chemistry will be found as fallacious as should be an attempt by such method to distinguish diphtheria antitoxin from tetanus antitoxin. Here the clinical dynamic investigation has proven to be the only efficient method leading to decisive results. Here it is not a question of prescribing on the one side and making up the prescription on the other. Here the question has been through and through to penetrate the darkness of the unknown with the means of investigation offered by any branch of science that could lend an assistance to the purpose, and thus to pave the path and kindle the light that shall make further progress by other investigators easier.

Regarding some or another detail in my discussion, different shades of view might perhaps be suggested. However that may be, two facts I purport to have established with certainty:

1. Orthoarteriotony, technically capable of realization through the action of iodine as surely as anesthesia is technically capable of realization through ether or chloroform, the purpose can invariably be attained by strictly following

the technical rules which emerge from my experimental findings and which I have formulated in my thesis.

2. Orthoarteriotony is not produced by anorganic iodine action, *i.e.*, is not iodide action, but it is a form of organic iodine action, *i.e.*, a result of chemical interaction of iodine and protein (or possibly some other organic molecule) in the blood or in the tissues.

REFERENCES.

[1] Compare Enebuske: Von der vasomotorischen Unruhe bei Geisteskranken. Zeitschrift für d. Ges. Neurologie und Psychiatrie, Berlin, 1916, xxxiv, 5, p. 459. *Idem.*: Vasomotor Unrest in the Insane, BOSTON MEDICAL AND SURGICAL JOURNAL, March 15, 1917.

[2] Compare H. Nothnagel u. J. Rossbach: Handbuch der Arzneimittellehre, Berlin, 1880, p. 259; R. Kobert: Lehrbuch der Intoxikationem, Stuttgart, 1904, ii, p. 184; A. Arnozan: Précis de Thérapeutique, Paris, 1903, i, p. 212; and others.

[3] Compare H. Meyer u. R. Gottlieb: Die experimentelle Pharmakologie, Berlin u. Wien, 1914, p. 484.

[4] Compare A. Hefter: Über Jodwirkung, Medizinische Klinik, Berlin, 1910, No. 8.
C. Enebuske: om verkan av jod; Svenska Läkaresällkapets förhandlingar, Stockholm, November 29, 1910.
H. Meyer u. R. Gottlieb: Die experimentelle Pharmakologie, Berlin und Wien, 1914, p. 383, and other authors.

[5] Compare H. Meyer u. R. Gottlieb: p. 484, (*loc. cit.*)

[6] Compare: Précis de Thérapeutique, par A. Arnozan, Paris, 1903, T. p. 212: "Introduit dans le sang, ce metalloid s'y combine avec le sodium et y circule sous forme d'iodure de sodium. Mais il n'est pas démontré, qu'il ne forme pas des combinations spéciales avec les albuminoides. ......on en est réduit sur ce point a des hypothéses on a des expériences *in vitro* toujours sujettes à des interprétations différentes."

TENDON SUTURE.

BY TORR WAGNER HARMER, M.D., BOSTON.

UNRETARDED strong healing of severed tendons after suture depends upon careful approximation of the severed ends by a stitch which will not destroy many tendon fibers either by transfixing or constricting, and so placed that it will not pull out with early use of the tendon. In certain situations, such as the wrist, early function is imperative in order to avoid fixation of the tendons by adhesions. The original wound and the traumatism of operation, however slight, including the suture of the tendon itself, will be followed by more or less connective tissue formation. If a suture is not sufficiently strong to endure very early use, this connective tissue formation may seriously fix the tendon to surrounding tissues. The liberation of the tendon may require weeks of massage and manipulation, and perhaps complete function may never be attained.

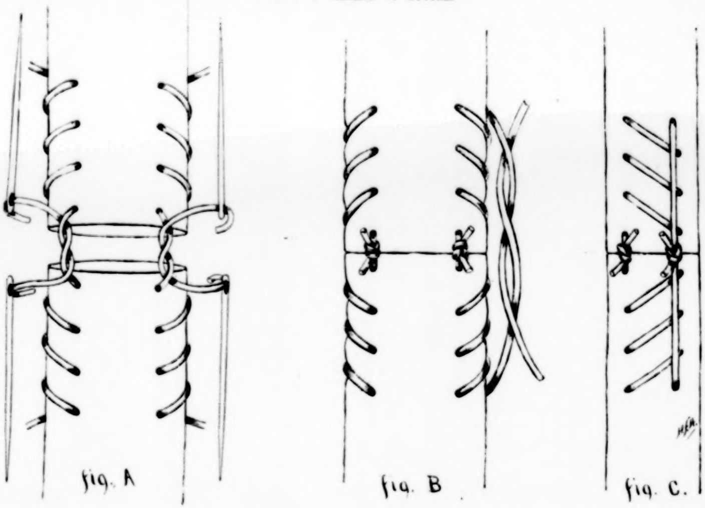
Since 1909 I have employed a method of treating severed tendons which may not be new, but has not been known to a number of surgeons with whom I have spoken. The series of cases is not large, but the results have been sufficiently satisfactory to commend the method. The severest test I am herewith reporting,—suture of twenty-four tendon ends on the anterior surface of the wrist three days after injury.

The stitch is of silk and consists of overcasting the lateral margins of both ends of the divided tendon. The overcasting starts about the width of the tendon or a little more back from the point of division, and comprises several whippings about the side of the tendon down to the line of division, each loop including somewhat less than one-quarter of the circumference of the tendon. When a tendon is ready to be brought together, each end then carries two stitches and each stitch two ends, as is shown in Fig. A. In this figure, although the short ends are shown partly knotted, they have been represented still threaded in the needles in order to indicate the directions in which the stitches have been placed. The full length of the long ends has not been shown in order to simplify the diagram. If there is more than one tendon severed, stitches are placed on all before any are tied. The two parts of the tendon are now brought together and the two suture-ends nearest the line of division on one side are tied. The two longer ends on the same side are then tied. The two pairs of stitch-ends on the other side are then similarly tied. In Fig. B the constrictions of the edges of the tendon beneath the overcasting stitches have been purposely exaggerated. In this figure both pairs of short ends have been tied, one pair of long ends is being tied, the other pair of long ends has been tied but is out of view on the under surface of the tendon. The long ends so tied alongside the tendon seem to serve as lateral splints. The objection that they occasion too much suture material in the wound is refuted by the fact that I have never seen any harm from them. It is likely that these lateral stays become incorporated with the sides of the tendon just as silk grafts in tendon lengthening. Sometimes after tying the stitch, the severed ends, although in contact, may slightly buckle. This is occasioned by tying the long suture ends too tightly. They should simply be made taut. If this error has been made, it may readily be corrected by placing a simple stitch between the tendon ends. There is no tension on this simple stitch. It merely closes the gap caused by the buckling. Fig. C is a side view of a sutured tendon. It shows how the tying of the two shorter ends tends to splint the tendon on its upper surface, and how the tying of the two longer ends tends to splint the tendon on its under surface. The tendon shown is a well-rounded one, and consequently the overcasting includes only a part of the lateral margin. In case of a flat tendon it would include practically the whole thickness of the lateral margin.

A dry wound before closing is desirable. Seeping or actual hematoma will probably limit the amount of motion at first, may favor the production of adhesions, or may encourage infection. It is important, then, to stop all bleeding, using as little material for ties as possible.

Care is taken in closing the wound to approximate the fascia and skin separately. *No splint is used.* Active motion is started as soon as the patient has recovered from the anesthetic. This will never be too energetically done on account of the pain which it causes. The dress-

DIAGRAM OF METHOD OF SUTURE.



SUTURE OF ALL FLEXOR TENDONS—23 DAYS AFTER OPERATION.

FIG. 1.

FIG. 2.

FIG. 3.

SUTURE OF ALL FLEXOR TENDONS—15 MONTHS AFTER OPERATION.

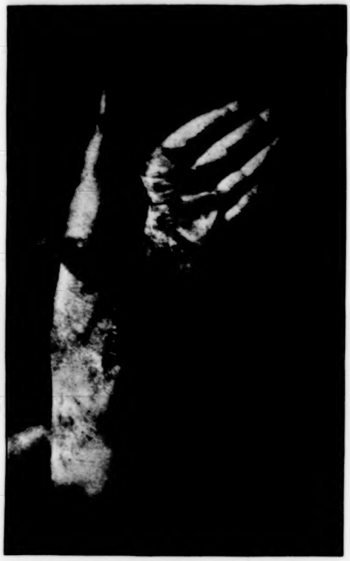


FIG. 4.

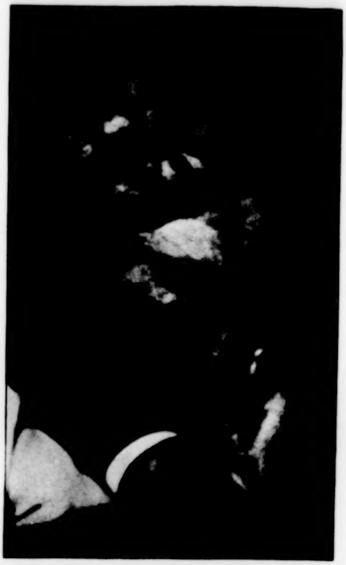


FIG. 5.

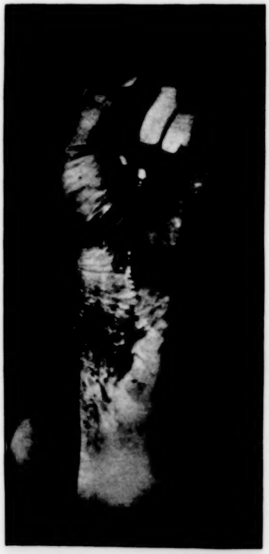


FIG. 6.

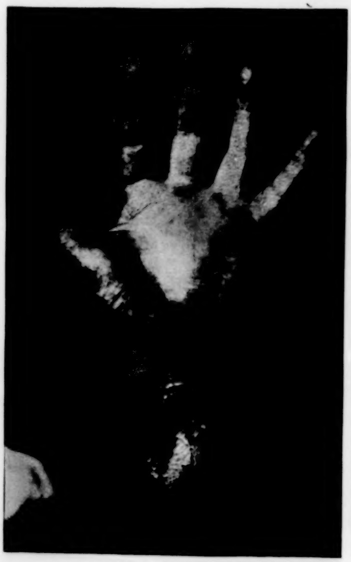


FIG. 7.

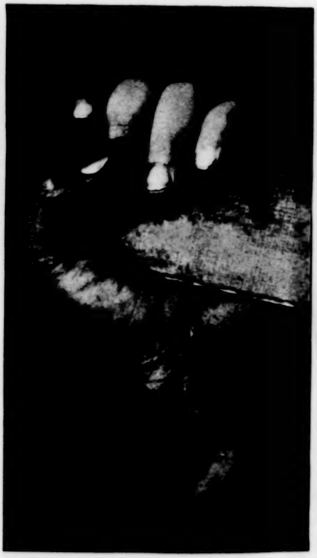


FIG. 8.

ing is rapidly reduced in bulk during the next few days so as not to interfere with motion. In a day or two the part is gently moved passively to allow the patient to see the amount of motion that can be accomplished. After three or four days of active motion he is permitted to use passive motion in addition. Even children, if properly handled, can be persuaded to tolerate the slight pain which active motion causes.

At the Children's Hospital on October 14, 1915, I saw a lad of five years who had fallen three days previously upon a milk bottle, lacerating the anterior surface of his forearm just above the wrist. Immediately after the accident, a physician had made an attempt to repair the wound, but it was quite obvious from the boy's disability that probably only a few superficial tendons had been united. Accordingly, under ether and ether-iodine preparation, the wound was reopened. The hospital record of the operation follows:

"Left forearm presents lacerated wound extending from about center of ulnar side downward to within 2 ins. of annular ligament in median line, then upwards and outwards for about 2 ins. There present in the wound the median nerve and the ulnar nerve, somewhat frayed. The tendons of the flexor carpi radialis, palmaris longus, of the sublimis, of the profundus and the flexor carpi ulnaris lay severed. The flexor longus pollicis is partly severed. The ulnar artery is severed. Lower ends of the superficial tendons had receded about 1 in. distally, but the deep tendons had receded under cover of the annular ligament, as was shown by a vertical incision carried from the V-point of the lacerated wound downwards into the palm, through the annular ligament. To the end of each tendon was fastened, on either side, a silk suture overcasting the lower margins. The 24 tendon-ends were approximated; the annular ligament brought together with No. 0 chromic, fascia similarly sutured. Silkworm gut to skin. Dry dressing; bandage; to ward in good condition. Time: two hours and ten minutes. No splint was applied and in the afternoon the boy was encouraged to use the fingers at once."

It is remarkable that the median nerve was not severed when the flexor carpi radialis and palmaris longus were completely severed and the flexor longus pollicis partly so.

Before placing any stitch on any of the tendons, and before moving any of the tendons from the position in which they lay, the wound was enlarged as much as was thought necessary. The tendons were then viewed as they lay, first the proximal group, then the distal group. Not a single tendon-end was disturbed until a decision had been reached regarding the identity of each end. Then before any tendon was moved, the pictures which the proximal and distal groups presented were visualized. The tendon-ends were then picked up one at a time, and the stitches placed first in the proximal and then in what was considered the distal end of each tendon. The ends of each tendon were then laid aside and their identity preserved by placing a certain number of hemostats or similar kinds of hemostats on the suture of each end. When all the tendon ends had been supplied with suture ends, they were tied together from within outwards. The annular ligament, fascia, and skin were closed as above noted. In order to test what I was convinced to be true from previous experience in less extensive tendon injuries, no splint was applied, and in the afternoon a special visit was made to the hospital to instruct and encourage the lad to use his fingers.

The house officer's post-operative notes follow:

"Oct. 15, 1915. Patient operated on yesterday. Boy uses fingers almost constantly as directed. All the tendons seem to be properly united. Upon forcible flexion (passive) of the fingers a snap was heard in the forearm. Patient allowed up with sling. Wound dressed and found to be clean.

Oct. 16. On examination of the fingers today it was found that the suture of flexor profundus indicis must have been loosened or drawn out yesterday when the snap occurred.

Oct. 18. Patient doing well. Wound not redressed. Patient is up and about with arm in sling. Is using fingers constantly. Hand shows some general swelling but otherwise seems in good condition.

Oct. 21. Dressing done today. Wound clean and healed. Active motion increased in amount.

Oct. 24. Stitches removed today. Wounds healed save for small area at tip of transverse flap. Dry dressing applied.

Oct. 27. Boy shown before Clinical Congress of Surgeons. All movements present except flexion of distal phalanx of index finger.

Oct. 29. Patient discharged home today. Result excellent. Has good functional result of all tendons save of the flexor profundus of first finger. To return to the Surgical O. P. D. for observation."

Twenty-three days after operation, a series of photographs was taken (Figs. 1, 2, 3, to illustrate the amount of motion of wrist and fingers. They show the original V-shaped lacerated wound and the incision made distally from the point of the V through the annular ligament. About this time the boy was placed in the care of Miss Miriam T. Sweeney, drector of Physical Therapeutics at the hospital. I wish to express my appreciation of her skilful and conscientious treatment, still further encouraging his active motions and directing passive motions and massage. I had a number of patients brought back to the hospital early this year to observe the end-results, among them this boy. A second series of photographs was taken at this time, February 2, 1917, fifteen and one-half months after operation (Figs. 4, 5, 6, 7, 8). No comment is necessary. They show practically perfect function of the wrist and fingers, with the exception of some weakness of the distal phalanx of the forefinger. Flexion of this phalanx can be accomplished, but not so vigorously nor so fully as the other distal phalanges. The boy has been seen again recently (November 12, 1917) twenty-five months after operation. All functions of the hand and wrist are perfect, and flexion of the distal phalanx of the fourth finger is practically complete. The scar is soft and flexible and not adherent.

This case, I believe, illustrates the importance of very early active function. It illustrates also, I believe, the reliability of this stitch, one which may be depended upon to tolerate early function, avoiding the use of splints and obviating in great measure the formation of adhesions. In the wrist and hand limitation of motion may prevent an individual from pursuing his or her vocation or avocation. Anchoring of flexor tendons not only limits flexion but also, to some degree, limits extension. *Vice versa*, limitation of extensor tendons limits not only extension but also, to some degree, flexion. In neglected cases secondary changes in ligaments and joints may follow, which may require the treatment of a skilled mechanotherapeutist before reconstructive surgery is attempted. The identification of tendons, the minimizing of operative traumatism, the preservation of grooves or gutters of tissue about which tendons which work at an angle may play, the use of fascia and fat, make this one of the most practical and fascinating fields of surgery. I have been persuaded by several men to place this case on record, and trust that the method may meet favor in other hands: this stitch, dry wound, separate closure of fascia, no immobilization, and immediate function.

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A METHOD OF TESTING THE VASOMOTOR REFLEXES OF THE SKIN AND OF RECORDING THE SAME.

By Edward A. Tracy, M.D., Boston.

All somatic phenomena are worthy of investigation and tabulation. In this way we learn to distinguish accurately what is normal from that which is abnormal. When certain abnormalities are found associated with certain disease conditions we are helped in the diagnosis of these conditions by the presence of the abnormalities.

In studying the reactions in the peripheral blood vessels caused by light stroking of the skin, I came to testing both sides of the face and both forearms (as these parts are readily accessible) and to record the findings in the timesaving manner described below.

In a normal person, when the skin is lightly stroked (with a pressure of about two ounces) there appears on the stroked surface a brief deepening of the skin tint lasting up to 8 or 12 seconds, and then a white streak appears that lasts for a couple of minutes. That is, in response to light stroking the local blood-vessels in the stroked area, or near by, first dilate and then contract. In a paper published in this Journal Aug. 10, 1916, it was shown that the dilatation of the vessels was caused by stimuli coming over the autonomic fibers of the vegetative nervous system, together with a certain hormone in the blood-stream, and that the vasoconstriction was caused by stimuli coming over the sympathetic branch of the vegetative nervous system, together with adrenin (or its analogue in action—pituitrin) in the blood-stream. A distinctive character in this reaction is that a single stroke of light mechanical irritation evokes a double reflex—that of vasodilation and vasoconstriction, through impulses coming over separate nerve structures—autonomic and sympathetic fibers. Of importance, too, is the fact of the dependence of these reactions upon the hormone content of the blood-stream. There must be a sufficiency of the appropriate hormones in the blood or the reactions fail to appear.

For the reasons mentioned at the beginning of this article, the phenomena of vasomotor reflexes were studied systematically and the findings tabulated.

The method used of testing the reflexes and of recording the findings is as follows: In each case four tests are made: 1. The skin of the left side of the face is stroked, and the length of time the reflex vasodilation lasts and the time it takes the reflex vasoconstriction to appear is noted; this is done with the aid of a stop-watch. The length of time the vasoconstriction lasts is also noted. 2. The same is done for the right side of the face. 3. The left forearm, on the palmar surface, an inch or so from the wrist, is similarly stroked, and the time it takes for the vasoconstriction to appear is noted. The time the vasoconstriction lasts is also noted. 4. The same is done for the right forearm.

The results of the testings are recorded by means of abbreviations, to save time. To illustrate the abbreviations made use of in recording the tests, let us suppose, on stroking the right side of the face, we note that the vasodilation is very brief—less than twelve seconds—and that vasoconstriction appears in twelve seconds and lasts two minutes. These facts are recorded thus: $\overset{\mathrm{d}}{\mathrm{rfc}}\ \mathrm{in}\ 12 = 2'$. If the vasodilation is not detectable, we can record this fact by a minus sign after the d, thus: d—. If the vasoconstriction is faint or diffuse we can so denote by the abbreviations f and dif. In some cases in which the vasodilation lasts longer than is normal—twelve seconds—a diffuse vasoconstriction is noticed bordering the stroked area, and a white streak is seen to replace the reddened one. These phenomena can be recorded—to take an example — thus: $\mathrm{rfc}\ \mathrm{in}\ 14''\ \overset{\mathrm{d} = 30''}{1\ 30''} = 3'$. This formula signifies that after lightly stroking the right side of the face, reflex vasodilation appeared and lasted thirty seconds and that reflex vasoconstriction appeared in fourteen seconds (bordering the red streak), and that the white line, replacing the red one, appeared in thirty seconds and lasted three minutes. (Parenthetically, I may remark here that the phenomena of vasoconstriction on the borders of reflex vasodilation appear to be due to an overflow of stimuli from the sympathetic fibers to neighboring fibers; the stimuli being prevented from discharging along the regular channels because of the nerve mechanism in the blood vessels being in use for the discharge of autonomic currents, the blocked sympathetic currents readily overflow into neighboring sympathetic fibers—the fibers being sheathless).

On testing the forearm, in general, only the time of the appearance of the reflex vasoconstriction, and the time it lasts, are noted. As a rule, the vasodilation is seen here with difficulty. On the face it is readily observed, and, lasting over twelve seconds, is, I have found, of pathologic import. It is convenient to stroke the skin on the palmar surface of the forearm an inch or two from the wrist, because of the presence of hairs and freckles on the dorsal surface which may hinder observation of the phenomena.

The abbreviations used in recording the tests made on the forearms are illustrated in the following examples: If we stroke the left forearm and find that vasoconstriction appears in ten seconds and that it lasts for two and a half minutes, we record the findings thus: lac in 10" = 2' 30"; and similar findings on testing the right forearm are recorded thus: rac in 10" = 2' 30"

In all cases in which the vasoconstriction is pronounced, that is, intense in color, we so denote by underlining the symbol for reflex vasoconstriction, c, thus: $\underline{c}$; if it be faint, the abbreviation f after the symbol c denotes that fact. To complete the record of the tests, the hour and date of taking them should be appended.

This method of testing the vasomotor reflexes and of recording the findings was employed by the writer in the hope that the study of the phenomena in a systematic manner might lead to some useful result. Nor has the hope proved fruitless. A study of the reactions in normal and diseased individuals has already led to important findings of use in diagnosis. The method is here offered to the clinician, that tests may be made and recorded methodically in various diseases. A larger knowledge of the phenomena of vasomotor reflexes will thus result, and light will be thrown on the involvement or not of the vegetative nervous system in these diseases, and on the sufficiency or insufficiency of the hormones in the blood-stream that are activated by currents coming over this system.

In testing for vasomotor reflexes it is important to use a light stroke, the pressure approximating two ounces. The ordinary wooden tongue depressor, with its edges smoothed, is used to evoke the reflexes. Heavy stroking produces reactions that are in part due to trauma; likewise, stroking with the finger nail. By practice we can learn to employ a light stroke—about two ounces of pressure. (The pressure employed can be measured by stroking the balance pan of a spring letter-scales.)

SPEECH CORRECTION—A NEW MEDICAL STUDY AND A NEW EDUCATIONAL MOVEMENT.

By Walter B. Swift, A.B., S.B., M.D., Boston.

Clinical Assistant in Laryngology, Harvard Graduate School of Medicine; Assistant in Laryngological Department, Massachusetts General Hospital Speech Clinic.

Teaching and research in the field of speech correction seem to have started with Gützman of Berlin: at least, most of the men who have become primarily interested in speech disorder originally studied under him. Dr. E. W. Scripture of New York used to be one of the chief authorities in the psychological phases of speech defect. The late Makuen of Philadelphia was long a leader in the subject, and from him sprang Kenyon of Chicago, who now teaches in the Rush Medical School. Horn of San Francisco, a pupil of Gützman, and Guggenheim of St. Louis, also deserve mention.

The speech clinics in Boston have sprung from similar sources. To the inspiration and training afforded by Gützman, Scripture and Liepman, however, were added special and protracted study in psychology, dramatic art, neurology, neuropathology, psychiatry, and general medicine. The Boston clinics were founded only after this extensive but necessary training had been completed. The variety of interest and scope of research in the clinics must be regarded as a necessary result of the variety and scope of this preliminary training.

In 1912 the voice clinic was started, and in 1915 the speech clinic. After my appointment to the laryngological department of the Harvard Graduate School of Medicine, I was given an opporunity to offer graduate and undergraduate courses. The undergraduate course consisted of clinical lectures and demonstrations to whatever members of the fourth-year class were assigned to me from those electing the study of laryngology. Here I treated speech disorder as part of the general subject; for since the functions of the speech mechanism belong in the field of the laryngologist, their correction, education and development also belong there.

To accommodate the special needs and interests of students, the postgraduate courses in speech correction were grouped under four heads: medical, psychological, treatment, and educational. The medical courses consist in medical instruction, with special reference to speech. For example, it is shown how enlarged tonsils interfere with early speech development, how cleft palate makes speech indistinct, how paralysis of the tongue muscles makes certain utterances impossible. The courses dealing with the psychological aspect take up the mental functions related to speech, considering their origins and the relations of eye and ear registrations of psychological interpretive processes and mental collaboration. Under the treatment aspect, the courses take up the eradication of speech defects. The courses dealing with the educational aspect cover the relationship of speech disorder to the public schools. Here an endeavor is made to elicit the interest of teachers in the medical phases of speech. As the medical practitioner must delegate to nurses a great part of medical treatment, so the medical speech specialist must rely upon the teacher. The education aspect, therefore, applies to the training of the speech nurse.

So much for the work in speech improvement that is being done in the Harvard Medical School. The more immediate aims of the two speech clinics in Boston are: to carry on research and to teach students. But there are other aims, more important and far-reaching. These are, first, to show teachers how to correct speech disorder in the public schools; second, to found other speech clinics under other medical heads; third, to establish other teaching centers as affiliated branches of the original home clinics.

These Boston clinics are dominated by the research spirit. Every patient is fitted into some research problem. Every student is given an investigation. This accounts for the extraordinary productivity of the two clinics during the last few years. During last year, about one hundred and twenty papers were read by my assistants and myself, and during the year before that, one hundred and ten. Yet we have done nothing that others could not have done with the same training and opportunities. We have been working in unplowed wastes.

The results of our researches cannot, of course, be given here in detail. The psychological background of stuttering has been investigated, and a new treatment, based upon this investigation* has been devised and published, with remarkable results. We have found that the peculiar speech of cleft palate patients is not due entirely to the cleft palate, and that it is capable of correction. We have found that mental defectives are capable of speech improvement and of some resultant mental growth, when put through a long series of vocal drill which has been formulated.

The internal interests of these clinics—treatment, research, and teaching—are the usual ideals of any clinic. Their external activities and influences are more unusual. Last year one hundred and three teachers studied the methods and systems of the clinics, and this fall they will be putting them in practice in the schools. They will found departments of speech improvement in the public school systems of their various cities and will form classes for the correction of speech disorder under medical supervision. The physicians who have studied in these clinics have later established speech clinics of their own, affiliated with the home clinic, with aims of mutual aid. Several of my graduate students, after a year or two of connection with the home clinic, have founded teaching centers elsewhere. Considering these external activities, it would seem proper to call this whole undertaking a speech movement.

A word may be said regarding the clinical method. The patient's history is taken in the ordinary way and he is given a thorough examination—physical, mental, psychiatric, psychological, and educational—before the more exhaustive examination of the functions of his speech mechanism. Then treatment is outlined and he is drilled individually or in a class. At the same time he is fitted into an investigation, and a minutely detailed record of progress is put down as data for some future use. At times there have been twenty-five or thirty researches going on at once. Graduate students enter at any time of the year and are registered in the graduate medical department. The courses are concentrated and given more frequently in August, when five or ten courses are under way. During last August, one hundred and sixty hours' instruction were given.

A speech laboratory is to be the next outgrowth of the work of the Boston Speech Clinics. Some apparatus for this has already been obtained, and one of the hospitals where the speech clinic is housed has offered to build the laboratory according to instructions, as soon as funds are available. There will soon be available a foundation fund of $20,000 permanently given for this undertaking and to be used by me until my successor has been appointed. The research in both clinics has become so voluminous that it is necessary to separate it from the clinic activities and carry it on by itself in an especially equipped speech laboratory.

SUMMARY.

Research in the psychology and physiology of speech correction, though begun some years ago by Gützman in Berlin and carried forward by his pupils in various parts of America, offers a comparatively new and fruitful field to the medical specialist. The work being done in Boston, under the superintendence of Dr. Walter B. Swift, is of two sorts. First, there are the courses offered by him in the Harvard Graduate School of Medicine, covering the psychological, medical, educational, and treatment aspects of speech correction. These courses last one month and comprise twelve lectures, each followed by an hour of clinical demonstration. Second, there is the work of the two speech clinics conducted by Dr. Swift in Boston. This is of a more practical nature and embraces research in the pathology of speech, treatment of speech defects, and the training of public school teachers in methods of speech correction.

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* A Psychological Analysis of Stuttering. *Journal of Abnormal Psychology*, November, 1915.

All physicians who have studied in these courses have founded clinics elsewhere, and several of the graduate students have established teaching centers in other parts of the country. Funds are already available to the amount of $20,000 for the founding of a speech laboratory in which all the research hitherto done in the clinics will be carried on under more favorable conditions.

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Book Reviews.

Obstetrics, Normal and Operative. By **George Peaslee Shears**, B.S., M.D., Professor of Obstetrics and Attending Obstetrician at the New York Polyclinic Medical School and Hospital. 419 illustrations, 745 pages. Philadelphia and London: J. B. Lippincott Co.

It was with great interest the reviewer took up this book to review, because on the first page of the preface appears this sentence: "Most obstetric works contain too much irrelevant matter and too little about the practice of obstetrics." It is doubtful if one can question that statement, and, with that sentence in mind, the reviewer began reading the book.

Shears' book consists of four parts:

Part I. Normal pregnancy, labor and the normal puerperium.

Part II. Pathology of pregnancy and labor.

Part III. Obstetric surgery.

Part IV. Pathology of the puerperium.

The "traditional sections" on embryology and anatomy the author has omitted.

The book is individualistic throughout and the author writes clearly and much to the point.

As it is to the author "to the last degree exasperating to find a long bibliography of the Chamberlen family and no information on axis traction forceps," so also is it exasperating to the reviewer to find the archaic pictures of resuscitating the newborn babe reproduced in this new work. From that first sentence the reviewer quoted, little did he think those three timeworn illustrations of the prolapsed pregnant uterus (page 245), the pregnant uterus in the sac of the inguinal hernia (page 246) the diastasis of recti muscles with hernia of pregnant uterus (page 247), would appear in this work. While the reviewer is speaking of the illustrations perhaps a few other remarks may not be amiss. Why, on page 66, should palpation of the abdomen be pictured with the physician wearing gloves, while, on page 335, palpation of the hydrocephalic head in utero calls for no gloves. There are other similar inconsistencies in the author's illustrations which are so evident that there is no need to remark on them.

As for the text, the author has put his operative technic and methods in a very clear, concise style. In the finer points of treatment and technic no two obstetricians will always agree, and it is not the reviewer's aim to point out these minor differences, but there are certain points of criticism that should be mentioned. In placenta praevia (page 479) the author takes a typical case and says the first thing to do is to rupture the membranes. The reviewer cannot admit that there is any such thing as a typical placenta praevia—there are too many variable factors always present: the parity, the cervix, its condition, position of the placenta, condition of mother and size of fetus—all of these are variable and, therefore, there can be no typical praevia, and so the first thing is not always to rupture the membranes. The author's advice of a slow delivery by version is as unsound as his advice to hurry delivery by the use of pituitrin is unsound.

The author's chapters on contracted pelvis, induction of labor, obstetric operations are all excellent. In the treatment of eclampsia, the author takes the stand that "operative delivery soon after the first convulsion carries a far better prognosis than this same measure performed as a last resort," and he is not impartial to a Caesarean section being done.

It has been a pleasure to study this book, although the reviewer holds many divergent views. The author's enthusiasm and sincerity make the book stand for advancement in obstetrics, and for that reason it is a welcome addition to our libraries.

The Treatment of War Wounds. By **W. W. Keen**, M.D., LL.D., Emeritus Professor of Surgery, Jefferson Medical College, Philadelphia. Illustrated. Philadelphia and London: W. B. Saunders Company. 1917.

There is nothing finer in the world than the existence of a spirit and a will that neither years nor circumstances can thwart or conquer. Dr. Keen has taught students and doctors for generations; and now chafing at the bit because he cannot fight in France, he turns his compelling spirit to a timely textbook of the war—"The Treatment of War Wounds." His name on the cover should make every surgeon open the little volume, and opening it once, means consulting it frequently.

It is by far the best, most complete and, at the same time, most condensed statement of the subject that we have seen. It is also the most recent. Letters from surgeons abroad increase its interest for those of us who, like Dr. Keen, stay at home; though few of us have his reasons for staying.

It is to be hoped that every surgeon in America will read this book carefully, for both the subject and the author deserve our best attention.

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CARBON DIOXID AND VENTILATION.

ONE of the important problems occurring in the construction of military cantonments on a large scale is the one concerned with ventilation and with the allotment of adequate air space to each individual. Because of the cost of space and material, no extravagance in space or in ventilating apparatus can be permitted, but all provisions must be at a minimum. Thus far no rational standardization of the minimum amount of air purity that each individual within the confines of an enclosure must have, has been determined. Yet arbitrary requirements in this respect have been laid out and are in use in many public buildings. Besides, the index of air purity and adequate ventilation has been determined in terms of carbon dioxid contamination of the air. Recent investigation has, however, established the fact that this index is not reliable, and the requirements for carbon dioxid freedom too exacting. Hall (University of London) pointed out that there were no deleterious effects experienced when the carbon dioxid contamination of the air was increased from the ordinarily permissible 6 to 8 parts in 10,000, even to 300 parts. The concentration of the carbon dioxid in the blood did not show any increase under this apparently enormous contamination. Carbon dioxid becomes an index only of the amount of respiration the air in a particular place has undergone. The amount suggests perhaps more positively than anything else the amount of organic matter present in the air which has been expired from the lungs of those present. And if the organic constituents of the air can be taken care of, the carbon dioxid is of no moment in providing for ventilation. In any event, the problem of heating and ventilation is not so much a matter of maintaining the chemical purity of the air, nor even of providing for the organic contaminations, but rather a problem concerning itself with seeing that the physical effect upon skin and mucous membranes is not one to diminish their normal physiologic action. In other words, ventilation and heating must concern themselves chiefly with the humidity or dryness of the air, as well as its temperature, and not so much with its chemical purity. When the humidity of an enclosure can be maintained between 40° and 45, the temperature between 60 and 65° F., and the air velocity between 1 and 3 feet per second, the carbon dioxid and organic contamination can be left to take care of itself.

In this connection it must be remembered, in spite of notions to the contrary, that the problem of adequate ventilation, that is, the interchange of respired air with fresh air in enclosures, is a problem of the warmer seasons of the year and not the colder ones. In the winter there is the problem of the waste of fuel from the unwarranted loss of heat in trying to overventilate, if the standard of ventilation is the carbon dioxid contamination. In the warmer seasons of the year the temperature inside and outside is very likely to be the same, and consequently there will be no movement or interchange of air necessary for ventilation, even when there is an opportunity for a maximum amount of change to take place. In the winter months, on the other hand, even with the minimum provisions for natural ventilation, the marked differences in temperature between inside and outside air encourages rapid air currents, maximum interchange and adequate ventilation. In order, therefore, to maintain proper ventilation in kind and in quantity during all seasons, due regard must be accorded these physical facts. Natural ventilation cannot be trusted to fulfill all these requirements evenly throughout the year. American ventilating engineers are resorting more and more to mechanical systems of ventilation, with the view both of giving the most adequate ventilation and of reducing, as well, the cost of fuel for heating purposes. The constant introduction of cold air into heated confines increases the cost of fuel enormously. Taking into consideration the harmlessness of carbon dioxid contamination, and in order to maintain proper temperature at a minimum cost, modern ventilating engineers are making provisions for the recirculation of the warm respired air, after washing to remove some of the organic additions. Only a small amount of fresh cool air is introduced at each washing. These ventilating systems can work with as little as 10% of fresh cool air, and without deleterious effect upon the health of the occupants. Outside of fuel economy, the greatest advantage of this system of ventilation is that humidity can be maintained at any required degree. Ventilation on a large scale in modern times is becoming more and more a science,—a mechanical science. Natural ventilation is being discarded as inadequate and wasteful of fuel, and as an empiricism having no place at the present time.

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VACCINATION AND TETANUS.

The elements of society opposed to vaccination against smallpox, besides opposing this procedure on the ground that it is inefficacious to prevent the development of this disease, oppose it on the ground that it is the means of introducing disease into the body, particularly syphilis and tetanus. The claim of inefficacy can easily be disposed of by calling attention to the fact that since the introduction of this means of prevention smallpox has almost entirely disappeared from civilized communities. The question of the introduction of syphilis has no force at present, because human vaccine virus is no longer used, and, so far as is known, syphilis is transmitted only from man to man and the higher apes. But when we come to the consideration of tetanus, it must be admitted that unless this factor can be disproved it is a serious arraignment of vaccination. With this point in view, an exhaustive study of vaccination tetanus was made by Anderson (Hygienic Laboratory Reprint No. 289). In the first place, it was found that during a period of about 10 years and the sale of over 40 million vaccine tubes, not more than 41 cases of tetanus had been reported. Even if the vaccine origin of these cases were authenticated, the percentage of infection would be almost infinitesimal. Examination of vaccines from the same stock that apparently caused infection failed to reveal the presence of any tetanus bacilli. Moreover, it was found on investigation that there were no other cases of infection with tetanus, although the same lot of vaccine had been used. In the same period, in over half a million vaccinations in the army, under strict supervision, not one case of tetanus developed. Experiments were undertaken to infect susceptible animals—monkeys and guinea pigs—with vaccinia and with tetanus at the same time, but while the vaccination "took," it was impossible to infect them with tetanus. This seems to prove that even in infected vaccine heavily laden with tetanus, there was little likelihood of the development of tetanus.

An intensive study of the data surrounding the 41 cases of tetanus revealed some interesting features. The average incubation period, reckoning from the time of vaccination, was 22 days and the mortality was 70%. And yet it is known that in tetanus from other causes, where the incubation is less than 10 days, the mortality is only about 61%—a very high mortality at best. In cases where the incubation period was more than 10 days, Anders and Morgan report the mortality as not over 41%. It would seem, then, that if the period of incubation in vaccine tetanus was 22 days, a mortality of over 70% was inordinately high, or else that the incubation period of this post-vaccine tetanus was in fact less than 22 days—perhaps even less than 10 days. In other words, infection did not have origin 22 days preceding the development of tetanus, that is, at the time of vaccination, and vaccination cannot justly be credited with the guilt for the development of this disease. It is more logical to suppose that this post-vaccination tetanus occurred as any other post-surgical tetanus,—from the introduction of tetanus bacilli through careless surgical methods without regard to the care of the vaccination wound. Indeed, in some of the cases investigated this was clearly proven. The removal of scabs, the presence of dirty vaccination shields and careless handling can all infect a vaccination wound. The removal of the crust or scab from the vaccination can allow infection with tetanus germs or spores, and the re-formation of the scab can produce the anaerobic conditions necessary for the development of tetanus bacilli. The question of the prevention of tetanus infection or other infections with relation to vaccination depends upon the strict enforcement of surgical cleanliness at all stages of the vaccinia. The absence of any case in the army, where such discipline, as well as other discipline, can be enforced, points to the direction in which more care must be exercised where large numbers are vaccinated.

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THE LAST ILLNESS OF GENERAL WASHINGTON.

The following interesting account of General Washington's last illness is from the "Library of Practical Medicine" for 1861. This volume was published by the Massachusetts Medical Society, for the Fellows. The title of the communication is: "Memoir of the Last Sickness of General Washington, and Its Treatment by the Attendant Physicians."

General Washington was in his 68th year, and had apparently been in excellent health up to the time of his brief and fatal illness. It has been popularly supposed that this last illness was due to "croup" or "quinsy." In the following account acute laryngitis is given as the cause of General Washington's death. The account was derived from Colonel Lear, within 24 hours of General Washington's decease, with an attestation as to its correctness, by Washington's friend and physician, Dr. Craik.

> "On the 12th of December, 1799, General Washington was abroad on his farms, on horseback from 10 o'clock a.m. to 3 p.m. Soon after he went out the weather became very bad, rain, hail, and snow falling alternately, with a cold wind. To the watchful eyes of his family there was no appearance of disease, though they looked for them, until the next day; he then complained of a sore throat. He had a hoarseness, which increased in the evening, but he made light of it.
>
> "The 13th of December he was kept from riding out by a snow storm. When in the evening Colonel Lear proposed that he should take something to remove his cold, he answered, 'No, you know I never take anything for a cold; let it go as it came.'
>
> "It was this night that his sickness arrested his attention. He was taken with an ague between 2 and 3 o'clock on Saturday morning, the 14th. He awoke Mrs. Washington, and told her that he was very unwell. He then had great difficulty in breathing, speaking, and swallowing. These symptoms continued till his death, which took place between ten and eleven o'clock the following night. It was also difficult for him to speak; it was breathing, however, which caused him the most distress. The efforts which he was compelled to make in breathing were extremely distressing, and occasioned great restlessness, the more because his strong efforts were insufficient to supply his lungs with as much air as his system had need of. His mind remained unclouded to the last. It is needless to say that he showed to the last those strong and great characteristics of mind and heart by which his whole life had been marked."

As far as treatment goes, we learn that General Washington was bled and blistered, and calomel and antimony were administered internally. From the symptoms described in the account of Washington's last illness it seems possible that he was the victim of a pneumonia of sudden and overwhelming intensity. The possibility of a pneumonia terminating so suddenly is borne out by modern clinical experience. This would in no way preclude the symptoms of an acute laryngeal trouble.

It is of interest to recall that General Washington's fatal illness occurred when Laennec, the originator of stethoscopy, was a youth of 18 years. Twenty years after General Washington's death, Laennec's great discovery was given to the world.

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MEDICAL NOTES.

An American Substitute for Salvarsan.—Announcement has been made unofficially in the daily press of the preparation of a substance to take the place of salvarsan. It is called A-189, and is said to be less dangerous to use than salvarsan and much less expensive. A single dose costs about five cents. The formula is perfected and the substance is ready for immediate manufacture. Announcement was also made of the effectiveness in cases of tetanus of an injection intravenously of a four per cent. solution of Epsom salts.

Communicable Diseases in Portland, Me.—The report for the year 1916 of the Board of Health of Portland, Me., shows that in a population of over 60,000, there were 113 cases of diphtheria, 57 cases of scarlet fever, 115 cases of typhoid fever, and 323 cases of measles.

Appointment to Chair of Tuberculosis.—Announcement is made that Sir Robert W. Philip has been unanimously elected by the Edinburgh University Court to the Chair of Tuberculosis, which has just been created in the University. This is the first professorship of tuberculosis to be founded in the United Kingdom.

Dr. E. O. Otis of Tufts Medical School holds the only professorship of tuberculosis in this country. His title is "professor of pulmonary disease and climatology."

WAR NOTES.

Health of Soldiers at Cantonments.—During the week ending November 16, there were 96 deaths at the National Guard and National Army camps. Pneumonia was responsible for 61 of the deaths. The rate in the National Guard is 42.6 per thousand, and in the National Army 28.5 per thousand. The highest rate is prevalent among Southern troops. Camp Travis at Fort Sam Houston, where measles is epidemic, had a rate of 87.9 per thousand. Camp Meade, at Annapolis Junction, Maryland, had the lowest rate, 9.1.

Dr. Blake's Hospital, Paris.—The hospital which was established by Dr. Joseph A. Blake in Paris, and which he and a staff of doctors have operated ever since the beginning of the war, will become American Red Cross Military Hospital No. 2, and will be for the use of American soldiers. Financial support has been arranged for under an agreement entered into by Dr. Blake, the Red Cross, the Service de Santé, and the United States Army.

Health of American Troops in France.—A report of health of American troops in France, issued by Surgeon-General Gorgas, covers the week ending Nov. 9, and shows the incidence rate of cases of principal diseases per thousand men as follows:

Pneumonia, 16.6; dysentery, 2.0; malaria, 1.0; venereal diseases, 181.5; typhoid, 0; paratyphoid, 0; measles, 21.7; meningitis, 1.0; scarlet fever, 1.9.

The non-effective rate per thousand for Nov. 12—which is the number of men per thousand who on the day reported were excused from duty for any indisposition whatever—was 31.6.

Total deaths for the week ending Nov. 9 were 8, as follows:

Pneumonia, 3; heart disease, 1; wounds received in action, 3; accidental gunshot wound, 1.

Killed and Wounded.—Report is received from General Pershing of the American expeditionary forces that First Lieut. Orlando Gochnaur, of the Medical Officers' Reserve Corps, attached to British forces, was killed in action on November 6. First Lieut. Alexander J. Gillis, of the Medical Officers' Reserve Corps, attached to British forces, was slightly wounded in action on the same date. Assistant Surgeon Dudley W. Queen, attached to the destroyer *Cassin*, which was damaged recently by a German torpedo, died on Nov. 20, at an Irish seaport. Dr. Queen was a native of Texas.

War Relief Funds.—On Dec. 1 the totals of the principal New England war relief funds reached the following amounts:

French Wounded Fund	$301,032.63
Armenian-Syrian Fund	261,972.80
Surgical Dressings Fund	139,763.09
British Imperial Fund	114,869.04
Italian Fund	56,436.94
LaFayette Fund	33,224.03
War Dogs' Fund	2,084.28

BOSTON AND MASSACHUSETTS.

Week's Death Rate in Boston.—During the week ending December 1, 1917, the number of deaths reported was 216, against 232 last year, with a rate of 14.58, against 15.90 last year. There were 31 deaths under one year of age, against 32 last year.

The number of cases of principal reportable diseases were: diphtheria, 111; scarlet fever, 28; measles, 68; whooping cough, 41; typhoid fever, 2; tuberculosis, 77.

Included in the above were the following cases of non-residents: diphtheria, 11; scarlet fever, 4; tuberculosis, 2.

Total deaths from these diseases were: diphtheria, 4; scarlet fever, 1; measles, 3; whooping cough, 1; tuberculosis, 28.

Included in the above were the following non-residents: diphtheria, 2; tuberculosis, 3.

Annual Meeting of Tuberculosis Society—The Boston Association for the Relief and Control of Tuberculosis held its annual meeting at the Twentieth Century Club, Boston. Dr. Cleveland Floyd, director of the out-patient clinic of the Boston Consumptives' Hospital, told of the handicap under which his clinic had worked because of lack of hospital facilities.

The below-par child, need of intensive education, and lack of an out-patient clinic, with modern equipment, where rapid diagnoses of cases could be made, he considered the vital factors in the situation.

Dr. John F. O'Brien of Charlestown outlined the history of that institution, and paid a high tribute to Edward F. McSweeney and Dr. James J. Minot. He also told of the intention to establish night camps for patients who have partly recovered and returned to work.

Dr. Edwin A. Locke, chief of the visiting medical staff of the institution, spoke of the need for employment as a part of the program of treatment to counteract the danger of making a loafer of the patient.

Mrs. Anna M. Staebler, secretary of the committee on health in industry, told of the work industrial nurses are doing for employees. The sanitary condition of workshops, she said, is often much better than that of homes.

Dr. Arthur K. Stone, president of the Association, in presenting his annual report, said that the deaths from tuberculosis in the State were 4466 in 1916, as compared with 4194 in 1915; in Boston the figures were 1166 in 1916 and 1029 in 1915. Judging by the first nine months, the 1917 figures would be about the same as those of last year. He ascribed the causes of this apparent increase to be better reporting of cases, and greater boldness of doctors in putting down the real diagnosis.

Faulkner Hospital.—The Faulkner Hospital, Jamaica Plain, reports an increase of 786 in the number of hospital days for the year ending May 1, 1917, with a total of 614 patients. The new maternity ward has been opened, and it is planned to increase the number of nurses from twenty-six to thirty-two.

Peter Bent Brigham Hospital.—The recently published report of the Peter Bent Brigham Hospital, which covers the year 1916, states that 3712 patients were admitted to the wards, 9810 new patients were treated in the Out-Door Department; the X-ray Department made 5504 examinations, and the serological laboratory made 3530 examinations. At the request of the United States Government, the Hospital will make a study of the effects of caffeine on the human body. Extended studies in asthmatic conditions have been made possible by a gift of money for that purpose. Similar gifts would be appreciated for study of cases of heart disease, diabetes, and Bright's disease.

The Massachusetts Medical Society.

NOTES FROM THE DISTRICT SOCIETIES.

District Correspondents.

Berkshire, A. P. Merrill, M.D., Pittsfield.
Bristol North, Arthur R. Crandell, M.D., Taunton.
Bristol South, Edwin D. Gardner, M.D., New Bedford.
Essex North, T. N. Stone, M.D., Haverhill.
Essex South, H. P. Bennett, M.D., Lynn.
Hampden, Laurence D. Chapin, M.D., Springfield.
Hampshire, E. E. Thomas, M.D., Northampton.
Middlesex South, William C. Hanson, M.D., Belmont.

Essex South District Medical Society.—Revised list of physicians in Government service Nov. 1, 1917:

Lynn—U. S. Army, Medical Reserve Corps, N. P. Breed, H. L. Davis, E. M. Dolloff, L. M. Hassett, C. L. M. Judkins, W. V. Kane, G. H. Kirkpatrick, W. F. Lemaire, L. H. Limauro, E. A. Merrill, C. H. Merrill, O. C. Spencer, J. W. Trask; Canadian Army, W. G. Shepard.

Salem—U. S. Army, DeW. S. Clark, E. A. Rushford.

Saugus—U. S. Army, G. C. Parcher.

Danvers—U. S. Army, A. P. Chronquest.

Beverly, U. S. Army, P. P. Johnson, H. E. Sears, W. G. Stickney, T. H. Odeneal

Lynn—U. S. Navy, Medical Corps, J. R. White; Medical Reserve Corps, G. W. Eastman, R. W. Mathes.

Gloucester—U. S. Army, Reserve Corps, S. W. Mooring.

Salem—U. S. Navy, Med. Reserve Corps, L. R. Chisholm.

Hamilton—U. S. Army Reserve Corps, C. H. Davis.

H. P. Bennett, *Secretary*.

Dr. P. P. Johnson has been advanced from the rank of Captain to that of Major, in the M. R. C., and has been transferred from Fort Benjamin Harrison to Fort Oglethorpe, Ga., for temporary duty.

The regular meeting of the Essex South District Medical Society was held at Beverly, on the evening of Nov. 22. Major Lund of Boston spoke on "War Surgery," and "The Need of the Medical Reserve Corps for More Volunteers."

The Anti-Tuberculosis Society of Beverly held a Health Exhibit at City Hall, from Nov. 15 to Nov. 18. The following persons spoke: Miss Besom, of the State Department of Health, on "Infant Welfare"; Miss Wood, of the Massachusetts Society for the Prevention of Cruelty to Children, on "Feeble-Mindedness"; Mrs. Miller, of Filene's Service Department, on "Economical Clothing in War Time"; Mr. Alton B. Briggs, of the Boston Fruit and Produce Exchange, and a member of Mr. Hoover's committee, on "The Food Situation"; Dr. John D. Adams, of Boston, on "Tuberculosis at Home and in Labrador"; Mr. Willis Chandler, Secretary of the Rhode Island Anti-Tuberculosis Association, on the "Red Cross Seal Campaign."

R. E. Stone, *Reporter*.

SOCIETY NOTICES.

Norfolk South District Medical Society.—Meeting for Medical Improvement at United States Hotel, Boston, Thursday, Dec. 6, 1917, at 11.30 a.m.

Reader: Dr. Frank A. Pemberton, of Boston.

Subject: "Hemorrhage from the Uterus in the Non-Pregnant Woman."

For Dr. Charles O. Day, of Hingham.

F. H. Merriam, M.D., *Secretary*.

The Harvey Society.—The fourth lecture of the series will be held at the New York Academy of Medicine, 17 West Forty-Third Street, on Saturday evening, Dec. 8, 1917, at 8.30 p.m., by Prof. A. S. Warthin, of the University of Michigan.

Subject, "The New Pathology of Syphilis."

F. H. Pike, M.D., *Secretary*.